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COMPUTERIZED SCHEDULING AND BROKERAGE DEMONSTRATIONS, EDMONTON AND VANCOUVER A COMPARATIVE ANALYSIS

Prepared for the
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17. Abstract

In 1985 the Transportation Development Centre of Transport Canada jointly sponsored two scheduling and brokerage demonstration projects, one with British Columbia Transit in Vancouver and the other with the City of Edmonton Transportation Department. The projects concluded in March 1987.

In Edmonton, a centralized brokerage system was established using commercial proprietary software to match client trip needs with the most cost-effective service option. A number of services were provided, including city-owned buses, taxis and owner-operated vans. A computer system was installed to support the operations of the brokerage centre. In Vancouver, an attempt was made to install a decentralized brokerage system in which an electronic network was to be used to allow information-sharing so that individual operators could coordinate services between themselves. The main emphasis was the development of the computer systems for the individual operators. Two computer systems were developed and the software was made available to other operators in Canada. The electronic networking was not achieved at this time but would form the next logical step.

This report provides a comparative analysis of the two computerized scheduling/ brokerage demonstration projects with regard to: project organization, approach, software/hardware, implementation strategy, project results and lessons learned. Both projects took considerably longer than anticipated, but produced systems and results applicable to both small and medium-sized special transit services.

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17. Résumé

En 1985, le Centre de développement des transports de Transports Canada a lancé deux programmes conjoints d'exploitation expérimentale d'un système de régulation/courtage des services de transport adapté, le premier de concert avec la British Columbia Transit à Vancouver et le second avec la Ville d'Edmonton.

A Edmonton, un système de courtage centralisé a été mis en oeuvre à l'aide d'un progiciel appartenant à l'entreprise privée et qui permettait de répondre aux demandes de déplacement reçues par la sélection de la prestation la mieux adaptée. Une gamme de services centralisés étaient fournis: véhicules de transport collectif, taxis et fourgonnettes privées. L'exploitation était gérée par un ordinateur central. A Vancouver, la méthode retenue a été celle de la régulation/courtage décentralisée, et la coordination devait être assurée par un réseau électronique destiné à faciliter le partage des informations sur la clientèle entre les entreprises concernées. L'accent devait surtout être placé sur la mise au point de systèmes informatiques exploitables par ces dernières. Deux systèmes informatiques ont donc été mis au point et les logiciels correspondants ont été testés et, par la suite, proposés à d'autres entreprises canadiennes. Quant au réseau électronique, il n'a pu être réalisé à temps, mais devrait constituer, en toute logique, l'étape suivante.

Le présent rapport établit le bilan comparatif de ces deux programmes: organisation, approche, matériel et logiciel informatiques, stratégie de mise en oeuvre, résultats et conclusions. Bien qu'ayant nécessité plus de temps que prévu, les deux programmes ont débouché sur des systèmes et des résultats qui peuvent intéresser des entreprises offrant des services de transport adapté, tant de taille petite que de taille moyenne.

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SUMMARY

In March 1985, in order to foster the development of technology to improve transportation services for elderly and handicapped persons, the Transportation Development Centre of Transport Canada initiated jointly-sponsored scheduling and brokerage demonstration projects with British Columbia Transit in Vancouver and the City of Edmonton Transportation Department.

The specific objective of both demonstration projects was to improve the quality and cost-effectiveness of urban transit services for disabled persons through the selection, implementation and demonstration of computerized scheduling/brokerage systems, with particular emphasis on the best application of microcomputer technology to the personalized form of transportation offered by special services.

Brokerage systems are designed to coordinate the supply of special transit services and stimulate increased transportation efficiency. The essential element of brokerage systems is information-sharing -- sharing information between different service providers about client trip needs and about the delivery of services to clients. Computer systems would appear to have a natural application to brokerage systems since computers are designed to improve the handling of information.

Computerized scheduling/brokerage systems offer a number of potential benefits for coordinating services and stimulating increased transportation efficiency. They could be used to assist in: (1) identifying specific travel demands, (2) selecting specific services to meet those demands, and (3) matching the demands with the provision of services in a cost-effective manner.

THE DEMONSTRATION PROJECTS

A decentralized scheduling/brokerage system was implemented in the Vancouver region by BC Transit in an attempt to utilize technology to (1) improve the administrative functions (particularly scheduling and dispatching) of existing special transit service operators and (2) improve communication and coordination between the operators. Operators were provided with computer hardware and software to be used for coordinating services, especially for travel demands outside of their particular zone of operation. An electronic communication network was to be used to facilitate the matching of travel demands with the most appropriate service option. Technology, not organizational structures, would be used to implement the brokerage aspects of the demonstration project. An electronic network was expected to allow various local operators to share information concerning service needs and the supply of services so that services would be better coordinated and efforts would not be duplicated.

A centralized scheduling/brokerage operation, the Custom Transportation Brokerage System, was implemented by the Transportation Department of the City of Edmonton to (1) better match the supply of services with the users' requirements and (2) test how could this be accomplished within an organizational framework of a mix of public and private ownership, operation and responsibility. The purpose of the demonstration project was to evaluate the concept of the brokerage system as a means of achieving the coordinated assignment of trips to the most appropriate service option, as well as to achieve greater fiscal control. It was hypothesized that vehicles other than those that are lift-equipped, such as private automobiles and taxis, could be utilized at lower cost and the brokerage management concept could be used to implement a range of cost-effective services; thus resulting in savings that could be used to provide additional service. In addition, the coordination of all services out of a central brokerage centre was expected to achieve other improvements in service quality, reliability, productivity and responsiveness that could not be achieved without strong central control and management.

The approach in Vancouver allowed BC Transit to realize the benefits of using local operators to provide a personalized form of service to their clientele and to reduce the problems resulting from a lack of coordination between operators. The system development efforts took longer than anticipated, however, and the networking aspect of the project had not been implemented at the time that this report was produced but is expected to be the next logical step.

The approach in Edmonton allowed the City to manage and schedule a complex mix of privately operated paratransit services designed to meet the specific needs of their disabled clientele in a most cost-effective manner. The application of computers was of secondary concern to the implementation of an appropriate organizational structure. Quality of service benefits was also realized with both brokerage systems.

THE APPLICATION OF COMPUTERS

Since the transit operators in Vancouver were relatively small, the approach was to provide them with small, inexpensive personal computers. Two different software applications were tested. One of the applications utilized graphical display technology to improve the scheduling/dispatching function. Operating on a local area network, the system provides a graphical display of available services and current demands as a scheduling/dispatching aid for operators. The other application was a computer software package for microcomputers that was upgraded to provide scheduling assistance through a tabular display of schedules for the operator. It also has the capability of operating on a multi-user microcomputer configuration. Both packages were made available to other operators in Canada for a nominal handling charge.

In Edmonton, the project was to facilitate the testing of an off-the-shelf computerized scheduling and management system that would be appropriate to the trip assignment and control requirements of the brokerage system. Two computer systems were tested (although these are not in the public domain and not easily transferable to other operators). The two systems were: (1) the (now defunct) computerized scheduling system that was in place before the demonstration, and (2) a commercially-available information management system.

THE RESULTS OF THE PROJECTS

The end products of the demonstration projects included: computer software packages for special transit service operators, including user manuals and tutorial programs; a report on computer-aided scheduling of special transit services; a report on the previous computer scheduling system in Edmonton; reports on the demonstration projects in both cities; and, audio-visual presentations on the results of the projects.

The final report on the demonstration project in Vancouver provides an overview of the project, focusing on a description of the two microcomputer applications. The applications environment, project organization, project approach, implementation procedure, impacts of the applications, results and conclusions of the project are described in the report. The report concludes that the use of microcomputers in smaller custom transit operations is certainly feasible. A reduction in operating costs of approximately five percent was achieved and the benefits easily exceeded the costs of acquiring computers.

The final report on the Edmonton demonstration project provides an overview of the project, focusing on a description of the implementation process. The approval and tendering process is described in the report, as are the transitional and labour-relations problems that were encountered. Various suggestions are provided for contracting for operations and for

developing operational policies. The report summarizes by drawing conclusions and describing implications of a brokerage system for users, contractors, city staff and other jurisdictions. The report notes that significant cost savings could be achieved. During the two years of the project, costs per trip declined by 12 percent in current dollars and annual trips increased by 18 percent.

The demonstration projects, which were completed in March 1987, illustrated both the feasibility of brokerage systems and the feasibility of using microcomputers in smaller custom transit services. They also illustrated the ease with which custom transit operators can adapt to the new technology and use it to improve client services. Finally, they illustrated the potential benefits to be achieved by coordinating a mix of public and private service providers in transit services for elderly and disabled persons.

In Edmonton, the emphasis during the demonstration project was on the brokerage aspect and, in Vancouver, the emphasis was on the application of computers. Consequently, the state-of-the-art of technology was further advanced in Vancouver with the development of new computerized scheduling/dispatching aids. In Edmonton, the state-of-the-art of organizational and contractual arrangements for providing service were further advanced using a commercially available database management program to keep track of client trip requests and service. This approach met the immediate needs in Edmonton but provided little impetus to new technological development for scheduling and dispatching special transit services for disabled persons.

With respect to transferability of experience, the results of the Vancouver demonstration project, in the form of the computer programs, were made readily available to other operators in Canada. The Edmonton computer system, on the other hand, is available through a private company. In addition, there is a concern as to whether the favourable results achieved with the brokerage system in Edmonton could be replicated in other cities in Canada not experiencing a similar economic climate.

SOMMAIRE

En mars 1985, voulant encourager la mise au point de technologies susceptibles d'améliorer les conditions de déplacement des personnes âgées et des handicapés, le Centre de développement des transports de Transports Canada, la British Columbia Transit de Vancouver et les services compétents de la Ville d'Edmonton avaient lancé un projet conjoint d'exploitation expérimentale d'un système de régulation/courtage des services de transport adapté.

Ce projet avait pour objectif précis d'améliorer la qualité et la rentabilité des services de transport adapté par la sélection, la mise en place et l'expérimentation de systèmes informatisés de régulation/courtage; l'accent était surtout placé sur l'exploitation optimale de la micro-informatique dans le domaine des services personnalisés de transport adapté.

Ces systèmes ont pour fonction de coordonner l'offre de transport adapté et, par là, d'améliorer la productivité des services concernés. L'essentiel de tout système de courtage se résume, d'une part, au partage des informations concernant les demandes de transport exprimées par la clientèle et, d'autre part, au partage des données sur les demandes de transport effectivement remplies. Les systèmes de courtage se prêtent naturellement à l'informatisation grâce à la maîtrise de l'information que celle-ci autorise.

Les systèmes informatisés de régulation/courtage considérés offrent de nombreux avantages étant donné qu'ils permettent d'assurer la coordination de l'offre de services de transport adapté et d'en relever la productivité: 1) en dressant la liste de toutes les demandes de transport reçues, 2) en choisissant les services en mesure de répondre à ces demandes et 3) en optimisant l'adaptation de l'offre à la demande.

EXPLOITATION EXPERIMENTALE

Dans la région de Vancouver, la BC Transit a mis en oeuvre un système de régulation/courtage décentralisé visant à lui permettre d'améliorer: 1) les fonctions administratives (établissement de la grille horaire et affectation des véhicules des entreprises de transport adapté existantes; 2) les communications et la coordination entre les entreprises concernées. A cet effet, ces entreprises ont été équipées de matériels et de logiciels informatiques dans le but de coordonner les services qu'elles proposent, en particulier à l'égard des demandes débordant la zone particulière où elles opèrent. Un réseau de télécommunications électroniques devait faciliter la sélection de l'entreprise la mieux placée pour répondre à une demande de déplacement donnée. Le volet courtage de l'exploitation expérimentale devait être servi par la technologie et non par la réorganisation, étant donné qu'un réseau électronique permettrait le partage des informations sur la demande de la clientèle entre les entreprises intéressées, lesquelles pourraient alors coordonner les prestations qu'elles offrent et éviter ainsi les dédoublements.

Quant à la Ville d'Edmonton, elle a choisi un système de régulation/courtage centralisé (Custom Transportation Brokerage System) lui permettant: 1) de mieux adapter l'offre de service aux besoins de la clientèle et 2) de vérifier comment cet objectif peut se réaliser dans un cadre où entreprises publiques et privées sont présentes sur le même marché. Le projet d'exploitation expérimentale avait pour objectif d'éprouver le concept de courtage associé à une affectation coordonnée des véhicules par la sélection de la prestation la mieux adaptée à la demande formulée, et aussi de réaliser un meilleur contrôle financier des opérations. Ce concept était basé sur l'idée qu'il serait possible d'utiliser des véhicules non équipés de plates-formes élévatrices (comme les voitures de tourisme et les taxis) dont l'exploitation est moins coûteuse, et qu'il pourrait être fait appel au système informatique de gestion afin de fournir une gamme de prestations à productivité élevée. Les économies en résultant pourraient alors servir à élargir cette gamme. De plus, on pensait que la mise en oeuvre du système de courtage centralisé pourrait déboucher sur d'autres améliorations (qualité, fiabilité et productivité accrues des services et adaptabilité à la demande), lesquelles n'auraient pu être réalisées en dehors d'un système de courtage et d'affectation puissant et centralisé.

La technique utilisée à Vancouver a permis à B.C. Transit de faire appel à l'entreprise privée pour fournir des prestations personnalisées et surmonter les difficultés posées par le manque de coordination. Malheureusement, la mise au point du système informatique a pris plus de temps que prévu, de sorte que le réseau de coordination électronique n'avait pas encore été mis à l'essai lorsque le présent rapport a été rédigé; cependant, la mise en place de ce réseau devrait, en toute logique, constituer l'étape suivante.

La technique utilisée par la Ville d'Edmonton a permis de gérer et de coordonner les services de transport semi-collectifs fournis par un ensemble très diversifié d'entreprises privées, de même que d'atteindre une rentabilité très élevée tout en offrant des services adaptés aux besoins de la clientèle.

Pour Edmonton, l'aspect informatisation passait après celui de l'organisation appropriée. Dans les deux cas, l'expérimentation a débouché sur une amélioration de la qualité des services.

INFORMATISATION

Etant donné que les entreprises de transport adapté de Vancouver étaient de taille relativement faible, il avait été décidé de les doter d'ordinateurs personnels peu coûteux. Deux progiciels de type différent ont été testés. L'un mettait en oeuvre une carte infographique dans le but d'améliorer les fonctions d'établissement des grilles horaires et d'affectation des véhicules; intégré dans un réseau local, ce système assistait les répartiteurs dans leurs tâches en leur fournissant un affichage graphique de tous les véhicules disponibles en regard des demandes de déplacement reçues. L'autre, approprié aux micro-ordinateurs, a été rendu plus performant par l'adjonction d'une fonction d'aide à l'établissement des grilles horaires sous la forme d'un affichage tabulaire; il présente aussi la particularité de pouvoir être exploité sur un micro-ordinateur à utilisateurs multiples. Les deux progiciels ont été mis à la diposition des entreprises canadiennes qui en avaient fait la demande, moyennant un prix symbolique.

Dans le cas d'Edmonton, le programme visait à faciliter l'essai d'un système informatisé de régulation/courtage disponible dans le commerce et apte à appuyer les fonctions d'affectation des véhicules et de contrôle financier nécessaires. Deux systèmes informatiques ont été testés, bien qu'il appartiennent encore au secteur privé et ne se prêtent pas aisément à un transfert de technologie; ce sont: 1) le système informatisé de régulation déjà en place au moment de l'exploitation expérimentale et maintenant mis au rancart et 2) un système d'information de gestion disponible sur le marché.

RESULTATS

Les produits tangibles livrés par les contracteurs ont été les suivants: des progiciels de régulation destinés aux entreprises de transport adapté, accompagnés des guides d'utilisation et des programmes d'initiation appropriés; un rapport sur la régulation assistée par ordinateur des services de transport adapté; un rapport sur le système de régulation assisté par ordinateur précédemment implanté à Edmonton; des rapports sur les projets d'exploitation expérimentale dans les deux villes et une production audio-visuelle présentant les résultats des deux expériences.

Le rapport final sur l'expérience de Vancouver récapitule le projet et donne une description détaillée des deux applications mises en oeuvre: environnement, organisation, approche, processus de mise en place, impact,

résultats et conclusions. Tous ces aspects sont abordés et décrits dans le rapport qui conclut à l'utilité des micro-ordinateurs pour la régulation informatisée des services de transport adapté, même dans le cas des entreprises de petite taille. L'économie d'exploitation d'environ 5% qui a été dégagée permet d'amortir rapidement le coût de l'informatisation de l'entreprise.

Le rapport final sur l'expérience d'Edmonton récapitule le projet et donne une description détaillée du processus de mise en oeuvre: approbation, appels d'offres, problèmes relatifs à la transition et à la main-d'oeuvre. Il propose des méthodes d'impartition et d'élaboration des techniques d'exploitation. Dans les conclusions qu'il tire, il décrit ce qu'un système de courtage assisté par ordinateur pourrait signifier à chacune des parties en présence: utilisateurs, entreprises de transport, municipalités et autres paliers de gouvernement. Il met en évidence les importantes économies d'exploitation que ce système permet de dégager; en effet, au cours de ce projet qui a duré deux ans, le coût par déplacement est tombé de 12% en dollars courants, tandis que le nombre de déplacements par an a augmenté de 18%.

Les deux exploitations expérimentales qui ont pris fin en mars 1987 ont montré l'utilité des micro-ordinateurs pour le courtage assisté par ordinateur des services de transport adapté, même dans le cas des entreprises de petite taille. Elles ont en outre mis en évidence la facilité d'adaptation des entreprises concernées à une nouvelle technologie qui leur permet d'améliorer le service à la clientèle. Enfin, elles ont fait ressortir les avantages possibles d'avoir une organisation qui fasse appel aux secteurs public et privé pour offrir des services de transport adapté.

A Edmonton, l'accent a été mis sur l'aspect courtage et, à Vancouver, sur les possibilités de l'informatique. Donc, l'apport de Vancouver a été la mise au point des nouvelles aides informatiques à la gestion et à la régulation des services de transport adapté; celui d'Edmonton se situait davantage sur le plan de l'organisation et de l'impartition des services, utilisant pour cela un progiciel disponible sur le marché, capable d'adapter l'offre aux demandes reçues pour des services de transport adapté. Cependant, si ce programme a permis de répondre aux besoins immédiats de la Ville d'Edmonton, il a fait très peu pour la mise au point de nouvelles aides informatiques à la gestion et à la régulation.

Sur le plan du transfert de technologies, les produits tangibles résultant de l'expérience de Vancouver, à savoir les progiciels, ont pu être mis à la disposition d'autres entreprises canadiennes intéressées. Par contre, en ce qui concerne Edmonton, le système informatique appartient encore à une entreprise du secteur privé. De plus, les chercheurs se demandent si le système informatisé qui a servi à Edmonton et qui a donné de bons résultats pourrait convenir à une autre ville canadienne dont la conjoncture économique ne serait pas la même.

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1. INTRODUCTION

Improvements and expansion of transit services for the disabled are often limited, not by demand (which is usually greater than the supply) but, by the efficiency of operations. In fact, these services tend to rely fairly heavily on management and control of the demand by means of eligibility criteria, ride prioritization or other service constraints. Improvements in service quality (and relaxation of the controls on demand) requires better responsiveness to the demands and/or better control and management of the supply of the services.

Custom transit services, by their very nature, are already extremely management and labour-intensive. Each client and each individual trip request has to be accounted for. Improvements in productivity and efficiency rely heavily on improvements in operations management -- which is often performed manually. Much of the operations management effort is concerned with recording, retrieving, exchanging and displaying information relating to the trip requests.

The extent to which computerized scheduling or brokerage management techniques can aid in the decision-making process involved in scheduling is a complicated issue. But it is in this area where the greatest benefits are anticipated. Matching the supply of available vehicles with the demand for trips, and making the most effective use of limited resources, is the challenge faced daily by managers of special transit services.

Computerized scheduling/brokerage systems are designed to coordinate and stimulate increased transportation efficiency by: (1) identifying specific travel demands, (2) selecting services to meet those demands, (3) matching the demands with the provision of services in a cost-effective manner.

COMPUTERIZED SCHEDULING/BROKERAGE

Brokerage systems are designed to coordinate the supply of special transit services and stimulate increased transportation efficiency. Coordination of services is a multifaceted concept -- in its broadest sense, coordination occurs whenever two organizations take each other into account in their decision making. A simple coordination activity in special transit involves the sharing of information between operators about client trip needs or about the supply of services. Since it is at this service delivery level that resources are expended, the anticipated benefits of coordination are greatest and the brokerage concept offers the most potential.

The brokerage management concept, as applied to the provision of transit services for elderly and disabled clients, has the potential of better meeting specific needs since it can be used to coordinate a range of possible service options. It can also potentially do this in a cost-effective manner, utilizing a mix of public and private service providers. The broker/manager is solely concerned with matching the needs of the clients with the possible service options -- not with operating the service.

Since computers are designed to improve the handling of information, it is clear that the computer can have an enormous impact on both the quality and speed of information flows within the management and operation of a special transit office -- thereby improving the capabilities of a brokerage system to share information about clients and their needs and to coordinate the service options available to meet those needs.

Vancouver's Emphasis on Computer Applications

A feasibility analysis (1) was undertaken during preliminary investigations that led to the demonstration project in Vancouver. The feasibility analysis was undertaken to determine: (1) the feasibility of using computers in small special transit operations, and (2) a proper course of action for BC Transit with respect to the application of computerized reservation/scheduling/dispatching systems to special transit in the Vancouver region.

The general approach in determining a proper course of action was to undertake a cost-effectiveness analysis of alternative computer system configurations and, in so doing, to determine the operational and economic feasibility of computer assistance in custom transit operations.

From the analysis undertaken which was based on a detailed review of manual scheduling and dispatching practices (2) and the information received from various system suppliers (3), it was concluded that the

application of computers to custom transit operations in the Vancouver Region was feasible from every point of view -- technical, operational and economic.

A centralized, decentralized and coordinated option was investigated. It was then concluded that the most feasible option was one in which a microcomputer system would be provided to each independent operator -- what was termed the decentralized alternative. An analysis of the coordinated option revealed that additional benefits can be achieved by investing in equipment to facilitate communications between the separate service operators' microcomputer-based systems -- essentially an electronically-networked brokerage system.

A final conclusion was that the decentralized system should be implemented in stages (in terms of both number of functions for each installation and number of installations) with adequate testing and demonstration before proceeding to the next stage.

Based on the conclusions resulting from the preliminary feasibility analysis, BC Transit decided to begin implementation of computer-aided scheduling systems in the Vancouver Region and, because of the potential transferability of experience offered by the microcomputer-based approach to other cities in Canada, requested Transport Canada to participate in the proposed demonstration project.

Edmonton's Emphasis on Brokerage Concept

Both a policy study and a feasibility analysis were undertaken during the preliminary investigations that led to the demonstration project in the City of Edmonton.

A study entitled "Handicapped and Elderly Transportation Policy Study" (4) was carried out by the City's Transportation Department in 1983 to: (1) review long-range policy requirements for transportation services for the elderly and disabled in Edmonton, and (2) develop strategies to satisfy future needs. The study noted that if future needs were to be met in a cost-effective manner, a substantial reorganization of the Disabled Adult Transportation System (DATS) would be required. The study also developed a comprehensive approach for future service planning.

Subsequently, the Transportation Department began a review of the 'brokerage concept' as it applied to the Disabled Adult Transportation Service (DATS). Consultants were engaged in January 1985 to review DATS and to determine the feasibility of the brokerage concept. The consultants report, entitled "Review of DATS and Proposed Brokerage Demonstration Project" (5), reviewed the potential for a more comprehensive 'brokerage' administration of several service providers under one management centre equipped with new scheduling/dispatching technology.

As a result of the review, the recommendation contained in the report was that the City should implement a centralized brokerage management organization for the dispatching of all DATS services. The report also outlined a strategy and process for the implementation of the brokerage. It was noted that the most important element controlling the reliability and cost-effectiveness of the DATS service is the dispatching function.

At the same time, an application was made to the Transportation Development Centre of Transport Canada for the funding of a demonstration project to test the brokerage concept and to test the application of an appropriate computer system for managing the brokerage functions. With financial support from Transport Canada, Edmonton's city council on April 23, 1985 authorized the Transportation Department to proceed with the implementation of the demonstration project.

THE DEMONSTRATION PROJECTS

In March 1985, in order to foster the development of technology to improve transportation services for elderly and handicapped persons, the Transportation Development Centre initiated computerized scheduling/brokerage demonstration projects in Vancouver with BC Transit and in Edmonton with the City of Edmonton Transportation Department. Both projects began in April 1985 and concluded in March 1987. The demonstration projects were initiated to explore the application of microcomputers to custom transit to improve the operating efficiency and effectiveness and to help managers better match supply and demand.

Objectives of the Projects

The specific objective of the demonstration project in Vancouver was to improve the quality and cost-effectiveness of transit services for the disabled through the selection, implementation and demonstration of computerized scheduling/brokerage systems, with particular emphasis on the best application of microcomputer technology to the personalized form of transportation offered by special services.

In Edmonton, the purpose of the demonstration project was to evaluate the brokerage concept as a means of achieving the coordinated assignment of trips to the most appropriate service option. The coordination of all services from a brokerage centre was expected to achieve improvements in service quality, reliability, productivity and responsiveness. In addition, the project was to test computerized scheduling and management systems appropriate to the trip assignment/control requirements of the brokerage.

The Differing Project Approaches

The project approach in Vancouver was one of incremental improvements to proven, operational systems in order to develop a generic computerized scheduling/brokerage system with minimum risk and maximum cost-effectiveness. Two proven software packages were to be tested and one was to be selected for expansion to all seven operators in the region. This system was to be expanded to promote optimum service delivery and the matching of supply with demand by establishing procedures for exchanging information between clients and operators through an intermediary coordinating computer network.

The general project methodology included the sequencing of activities and decisions leading to the definition, development, and implementation of computerized scheduling systems for custom transit services. An iterative process was used to tailor the computer systems in relation to the requirements, constraints and capabilities of the operators.

The project approach in Edmonton was one of re-organization -- the creation of a centralized scheduling, dispatching and administrative centre which could, through contractual relationships with a variety of service options, 'broker' trips to the most cost-effective provider given the requirements of the client. It was hypothesized that cost savings could be achieved by allocating trips to lower-cost options such as taxis or private owner-operated vans.

The general project methodology was a 'phasing-in' process. A broker/management/consultant team was engaged under a separate dispatching contract for a period of time to test the new organization and technology prior to absorption by the City. The previous operating staff were phased into the new brokerage operation, and the contracted brokerage operating staff were phased into the civic staff. The phasing-in process was used to tailor the administrative requirements, constraints and capabilities to the needs of the service prior to establishing control by the City.

Comparable Project Organizations

The demonstration projects have been under the direction of a Steering Committee composed of representatives from the Transportation Development Centre, BC Transit, the City of Edmonton, the Canadian Urban Transit Association and several provincial transportation ministries, including Alberta, Ontario and Quebec.

In Vancouver, the overall project organization consisted of a Management Committee, Operators (Users) Advisory Committee, Project Coordinator and other support and operating staff. In Edmonton, the project organization consisted of a Custom Transportation Services Brokerage Manager and staff, a consultant team, city support, operating and administrative staff.

A COMPARATIVE EVALUATION

The purpose of this report is to provide a comparative evaluation of the two computerized scheduling/brokerage demonstration projects in Edmonton and Vancouver which were sponsored by the Transportation Development Centre of Transport Canada.

The Transportation Development Centre of Transport Canada (TDC) had retained TransVision Consultants Limited to undertake the comparative evaluation.

To satisfy the objective of this task requisition under the TIES Program, TransVision undertook a review of the final evaluation reports of both demonstration projects:

- "Vancouver Computerized Scheduling/Brokerage Demonstration Project: Final Evaluation Report" (6), TP 7657E, the final report, reviewing the overall demonstration project in Vancouver;
- "Custom Transportation Brokerage Demonstration Project: Final Evaluation Report" (7), TP 8331E, the final report, outlining the results of the demonstration project in Edmonton.

The comparative evaluation of the two demonstration projects outlined in the following pages is built upon the results presented in these final evaluation reports.

2. SETTING

Understanding the project setting in which plans, actions and results take place has a key role in the overall research and development process. Demonstration projects are often embedded in a complex milieu that includes the recipient user organization, the sponsoring agencies, the research and development team, and the social, political, and economic environment in which the new systems are being implemented. Successful management of the demonstration project depends on an understanding and awareness of this environment in order to detect change, assess its impact, and trigger changes in the system development plan.

In Vancouver, a relatively stable environment was experienced due to the fact that the demonstration project took place within the offices of the existing individual special transit operators. Several individual operators were affected, but the overall custom transit service program, as it was applied in the Vancouver region, was relatively unaffected. In Edmonton, the environment was considered to be a constantly-changing environment since the demonstration project affected the total special transit system within the City: the organization that was administering the service, the operators providing the service, and the users who were using the service.

In Vancouver, the existing individual special transit operators were considered small operators. Thus, an opportunity was provided to develop systems that could be used by many other such small operators throughout Canada. The environment in Edmonton was one that was experienced by many other medium and large transit authorities in Canada. The opportunity provided was for the development of systems and procedures for other large systems in Canada to improve the cost-effectiveness of special transit operations.

SPECIAL TRANSIT SERVICES

Special transit services are generally demand-responsive transit services provided for individuals with disabilities sufficiently severe that they are physically unable, without assistance, to use conventional public transit with dignity. They provide a parallel door-to-door transit service that is scheduled on a request basis for eligible users who telephone for service. Vans or small buses outfitted with wheelchair lifts are generally used. Lately, however, the use of taxis has been finding favour in Canada as a means of providing a supplementary and complementary service.

Private rehabilitation and charitable organizations were among the first in Canada to introduce special transit services for transporting disabled persons whose mobility was reduced. Because they were highly adaptable to time, space and quality requirements, special transit services were an obvious solution to the problem and thus were long regarded as an excellent means of solving the transportation problems of disabled persons.

Most urban communities in Canada have special transit services. In fact, smaller communities, without conventional transit services, often have some service for the elderly and handicapped. It has been estimated that more than $60 million is spent annually in Canada providing door-to-door custom transit service for disabled people in about 330 cities. Each trip costs an average of $13 to provide, with productivity typically just over two rides per hour.

Special Transit Services in Vancouver

BC Transit, the provincial crown corporation responsible for all transit services in the Province, introduced the Custom Transit Services Program in April 1980. Prior to the introduction of this program, transportation services for handicapped persons were provided by various charitable and community organizations as a supplemental service to their other social service operations. Funding was provided by charitable donations and the Provincial Ministry of Human Resources.

The Custom Transit Services Program provides a policy, funding and administrative framework for the provision of custom transit services in the Province. BC Transit contracts with private companies or nonprofit societies to operate the service, supplies the vehicles and equipment, assists in administration, and is responsible for service specification, funding, planning, marketing, monitoring and evaluation activities.

As a result of the introduction of the Provincial Program, the Vancouver Region was divided into service areas along municipal boundaries, with

independent operating companies providing service within each area. The five service areas since July 1986 and the operating companies serving them are: (1) City of Vancouver: Pacific Transit Cooperative, (2) North Shore: HandyDart North Shore, (3) New Westminster, Burnaby, Coquitlam: Western Society for Senior Citizens Services (with Royal City Taxi Supplement), (4) Richmond: Richmond Volunteer Transportation Society, (5) Delta, Surrey, White Rock: Deltassist Society, Surrey Community Resource Centre Society and White Rock Community Aid Society.

The delivery of service in the Custom Transit Program is the responsibility of the seven operators. These locally-based operators provide a very personal and, in many cases, a cost-effective service for the clientele in their respective communities. However, they operate in distinct geographical zones within the region, and there is little coordination between them. This raises a concern for the overall efficiency and effectiveness of the service.

The two special transit service operators of major interest, the candidates for this demonstration project were the Western Society for Senior Citizens' Services and the North Shore HandyDart Service:

Western Society for Senior Citizens' Services. One of the demonstration systems was to be tested at the Western Society for Senior Citizens' Services. The Western Society is a non-profit society administering various services for senior and disabled citizens in New Westminster, Burnaby, Coquitlam, Port Coquitlam and Port Moody.

The Western Society has approximately 2800 registered clients on file and provides approximately 350 trips per day of which 175 are regular subscription trips, 140 are advance reservation and 35 are on-demand. The Society has an office staff of five which includes an administrator, two dispatchers, a telephone receptionist and an assistant administrator who also does the bookkeeping. The fleet consists of 16 vehicles (14 vans and 2 cars). There are 18 full-time and 4 part-time drivers. The Western Society also uses a taxi service to provide trips that can not be served with the vans. There are between 30-35 trips served daily with taxis.

The other computerized scheduling system was intended to be tested at Pacific Transit Cooperative in Vancouver. Unfortunately, during the implementation, operational contracts were renegotiated and a change in status of Pacific Transit warranted a change in venue for the project. The North Shore HandyDart Service was subsequently selected.

The North Shore HandyDart Service. The North Shore HandyDart Service is a company providing services on the North Shore in the Vancouver Region, including the cities and district of North and West Vancouver.

North Shore HandyDart has approximately 600 registered clients on file and provides about 150 rides per day, of which about one-third are

regular subscription trips and two-thirds are advance reservation trips. Seven vehicles are used and nine drivers are employed. The office staff consists of a part-time office manager, a part-time accountant and a full-time supervisor. The manager is responsible for staffing, administration and reporting. The supervisor does the dispatching and supervises the drivers. The supervisor also accepts telephone requests, schedules trips, confirms trips and handles cancellations and call-backs. The supervisor also assigns trips to the vehicles over the radio and records the vehicle assigned to each trip. The part-time accountant prepares payrolls, accounts payable and invoices.

Special Transit Services in Edmonton

Edmonton, Alberta is Canada's largest northern city. Its 1986 population was 525,000 people within a metropolitan area of 657,000. Conventional transit and the paratransit services for the disabled are provided through the Transportation Department of the City.

The Disabled Adult Transportation System (DATS) was designed to meet the needs of mobility-impaired individuals who were unable to use regular public transit in Edmonton and has been in operation since April 1975. It evolved through several bus and van operators, and through several administrative and organization structures.

In its form prior to the demonstration project, DATS was a door-to-door transportation service for Edmonton citizens who were at least 16 years of age and who were unable to use the regular public transit service because of physical disabilities. All users of the system had to register with DATS (eligibility for registration was verified by DATS staff) or had to be registered in a program which contracted its transit service to DATS (i.e. the ACT Centre which provided programs for the disabled).

DATS service was provided on a pre-scheduled basis for both subscription trips which occur regularly on the same days of the week and reservation trips which may be booked up to 48 hours in advance or up to 4:00 p.m. the day prior to the trip. Service was provided seven days a week from 0630 to 2400 hours within the City limits. The pre-scheduled basis of service was adopted to achieve an acceptable balance between user convenience and system productivity.

DATS provided about 1100 trips per day with 45 vehicles, 39 full-time drivers and 48 part-time drivers. Three separate services were operated under contract by two independent contractors and these provided door-to-door specialized transportation service to Edmonton's disabled community: (1) the Regular DATS Service provided lift-equipped vehicles for the ambulatory and non-ambulatory. Services complementary to the Regular Service were provided by (2) the Sedan Service and (3) the recreation and Charter Service for the ACT Recreation Centre. The services started in

1973 with five vehicles serving 250 trips per day. Applicants for the service were screened for eligibility before they were permanently registered with the DATS service. In 1986, there were 6890 active registrants with approximately 45 percent of them in wheelchairs.

Users could book subscription trips for repetitive trips or advance reservation or demand trips for single outings. Approximately 35 percent of the trips were subscription trips and 35 percent were demand trips, the rest were advance reservation or prebook trips. About 40-50 trips per day were refused because the requests could not be met with the available resources or systems. The peak demand was during the normal peak hours. Priority was given to work, education and medical trips.

After ten years of experience, DATS was a well-established system with its clientele, meeting the specific and unique requirements of the adult disabled citizens in Edmonton. There was a concern for the future, however, for greater fiscal control and accountability, and for more cost-effective means of providing the service so that expansion could occur.

PREVIOUS COMPUTER SYSTEMS

Vancouver's Previous Computer System

Early in 1983, BC Transit began to explore the feasibility of installing a computer in the Victoria custom transit operation to assist in organizing passenger and trip records. The system was implemented in the Victoria office in September 1983 and has contributed to a number of administrative and service improvements. The same system was implemented in a second custom transit office in Kamloops, B.C. in March 1985.

The hardware acquired for the Victoria operation included an Onyx multi-user computer, two monitors and keyboards, and a dot matrix printer. All programming was done using the Cobol language. The total cost of this two-user system was $19,000 for the hardware and $41,000 for the software (including BC Transit staff time and software development).

The software was the product of a number of sources of information. Many of the concepts and definitions were adapted from other systems. For example, the registration file was similar to that developed in Ottawa. Other aspects of the system were adapted from a doctors scheduling package developed by a local firm. The majority of the specifications for the software, however, were developed by BC Transit and the operating company in conjunction with the developer to meet the criteria set out for the special transit operation in Victoria.

The software development went through three phases. The initial package was implemented in September 1983. It included the primary client registration and trip statistics files. Minor modifications to these programs and the trip statistics programs were added early in 1984. In June 1984, the software package was updated to provide the ability to print trip tickets and mailing labels. As well, the ability to print summary information on clients by zone and disability was added.

The Victoria computer system precipitated a 35 percent increase in the productivity of the service. Over the eighteen month period from September 1983 to March 1985, the number of rides per hour increased from 2.0 to 2.6. The 11,000 additional trips provided at the higher productivity level would have required more than 6,000 hours of service at an annual cost of about $150,000.

The installation of the computer in the Victoria office illustrated the potential of computer systems. It provided the operator with the capability of merging information from numerous files to aid in the production of efficient vehicle schedules. It infused an interest in applying similar systems to other operators in the Vancouver Region.

Edmonton's Previous Computer System

In 1981, D.W. Ellis & Associates Limited was retained by Edmonton Transit to perform a feasibility study on the automation of the process of routing and scheduling the DATS vehicles. The feasibility study lead to the development of the DATS Scheduling System. The System was developed and implemented over a twenty-month period between December 1981 and August 1983 in three stages:

- Stage I - the development of a computer support system for the existing manual registration, monitoring and scheduling.
- Stage II - the development of features to allow computerized scheduling of single trips into existing schedules.
- Stage III - the inclusion of the ability to schedule, from scratch, a day's routes to ensure more efficient service usage.

The implementation of the DATS Scheduling System on Edmonton Transit's Hewlett Packard 3000 Series III computer initiated a period of intense interest in transportation services for the disabled. The central element of the system was a scheduling algorithm for inserting trips into a series of routes and schedules already developed. This scheduling algorithm is probably one of the first fairly successful attempts at the routing and scheduling problem of these services using time windows to ensure compliance with operating policies.

An important feature of the system was that the scheduling algorithm had been tailored to the actual requirements and operating policies of DATS.

Thus, the service standards, requests for service, trip policies, and so forth were all unchanged when the DATS Scheduling System was implemented. The Scheduling System, with a scheduler, performed the dial-a-ride routing and scheduling of vehicles and the data processing activities that supported it. But the system was considered deficient in the areas of report generation and general management information.

The implementation of the computerized scheduling system introduced a number of systematic methods for performing the necessary office functions in the transit service. As a result of the introduction of these systematic methods, the productivity of the service improved at the time of implementation of the computer system.

The system also, however, increased the awareness of other potential improvements which could not be realized due to the limitations of the system design. In response to the system's inability to meet the increased expectations, some manual procedures were implemented to compensate that may have adversely affected the operation of the service and the perception of the value of the system.

Unfortunately, the DATS Scheduling System had a number of deficiencies which rendered it unsuitable for future planned service operations expansion and coordination necessary for the proposed DATS Brokerage Centre. The deficiencies included: lack of management information, lack of capabilities for expansion, lack of flexibility, and difficulty inherent in maintaining the system. Not as obvious, but potentially the most problematic, were internal logic flaws in the algorithm that tend to produce irrational and duplicate service on the road. One of the most serious deficiencies was that, due to the basic system structure, users could not learn from the system and improve the system based on that learning process (8).

It was therefore recommended that the City of Edmonton Transportation Department seek information about other existing computerized scheduling systems through the Request for Proposals process. It was further recommended that if, after reviewing the responses, it was discovered that no system currently existed that met the requirements of the DATS Brokerage Centre, then consideration should be given to further system design and development work on the current DATS Scheduling System.

Based on these recommendations, the City of Edmonton began a process to investigate alternative computer systems that might better support the trip assignment and management control requirements of the proposed brokerage centre.

3. ORGANIZATION

The scheduling/brokerage demonstration projects in Vancouver and Edmonton were like any demonstration project: they were a well-defined effort that produced specified results in a given situation at specified times. Although such projects vary in size, duration, and complexity, each has a specific objective; when that objective is met, the effort is complete. Project management acknowledges these characteristics and provides a means for dealing with them in a controlled, organized manner.

The basic elements of effective project management are discussed in this chapter as they were applied to the Vancouver and Edmonton demonstration projects. In Vancouver, a more formal project management structure was used due to the number of operators, consultants and suppliers involved. In Edmonton, there was more concern for the daily operations of the brokerage centre and project management was less formal.

The demonstration project in Vancouver was managed by BC Transit, with a consultant retained as the project coordinator. A large portion of the project effort was undertaken by BC Transit staff. A BC Transit Project Management Committee directed and controlled the project. The project coordinator acted as an advisor and facilitator and was mainly responsible for documenting the efforts of the project team and the project results.

The City of Edmonton appointed a Brokerage Centre Manager to manage the centre and overall direction for the project was provided by senior staff in the Transportation Department. A consultant team was retained to manage the demonstration project and undertake the work required -- even to operate the scheduling and dispatching centre during the project. A large portion of the project effort was undertaken by the consultant.

MANAGING THE DEMONSTRATION PROJECTS

Project management is the planning, directing, and controlling of resources to achieve established goals. With project management, temporary teams of personnel can devote their skills to accomplishing project objectives; they remain together only until those objectives are met.

The overall project organization for the Vancouver project, consisting of a Steering Committee, BCT Management Committee, Transit Operators, Project Coordinator and other support staff, is illustrated in Exhibit 1. The overall project organization in Edmonton, consisting of a Steering Committee, Brokerage Centre Manager, Brokerage Supervisor and other contracted support and operating staff, is illustrated in Exhibit 2.

Both demonstration projects have been under the overall direction of a Steering Committee composed of representatives from the Transportation Development Centre, BC Transit, the Canadian Urban Transit Association, the City of Edmonton, and several provincial transportation ministries -- Alberta, Ontario and Quebec.

In Vancouver, the BCT Management Committee, comprised of BC Transit management staff, undertook overall project monitoring, budget and contractual control, and coordination functions. The Management Committee appointed a staff person as the Project Manager, responsible for internal project management, coordination, and project monitoring. The Project Manager acted as liaison between the parties involved. In Edmonton, these functions were performed by the Manager of the Brokerage Centre, a City employee reporting to a Director within the Transportation Department, who was supported by three City employees: a Registration Clerk, a Transportation Technician, and a Planning Supervisor.

In Vancouver, the operators were involved in helping to design and implement the computer systems. The custom transit operators, especially, were instrumental in helping to design, test and define modifications for the computer systems. The dispatch office operations in Edmonton were managed by a Brokerage Supervisor who, together with the dispatch office staff, were provided through management contracts with Louis G. Grimble Professional Engineer Limited. In Vancouver, a Project Coordinator, TransVision Consultants Limited, was retained by BC Transit to provide detailed project monitoring, control, coordination and reporting. In both cases, other services and suppliers were contracted for as required.

In Edmonton, the City planning staff handling the registration files, complaint investigations, surveys and statistical analyses were transferred from the downtown planning office to the new Brokerage Centre so that

Exhibit 1: Project Organization in Vancouver

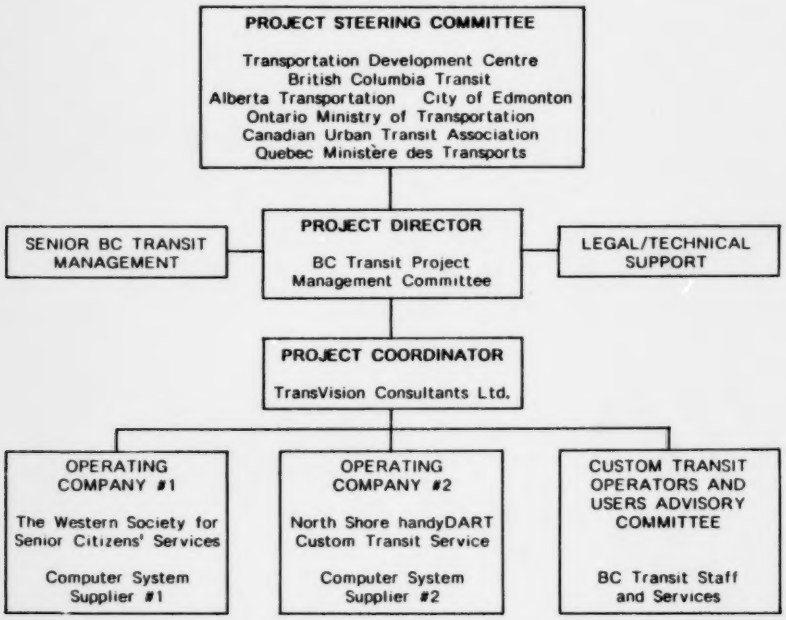
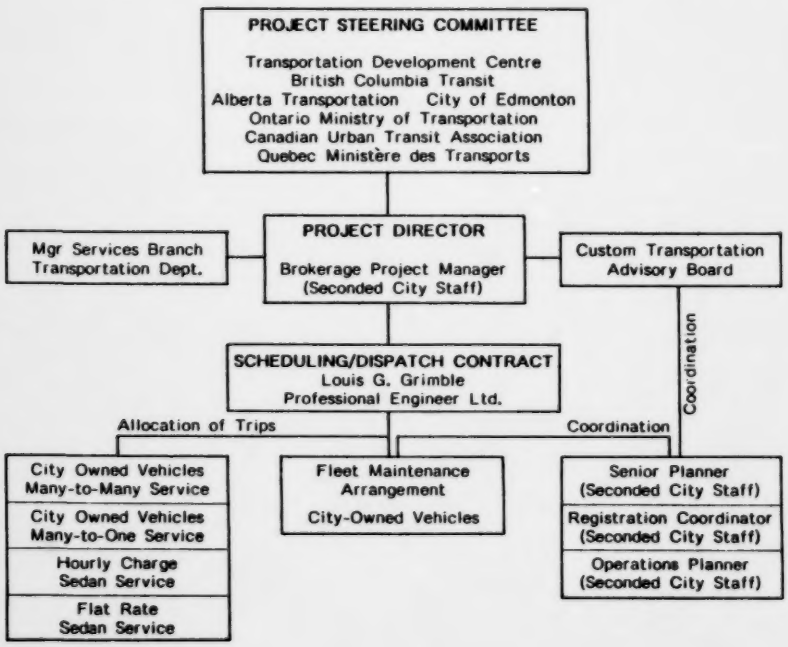

PROJECT STEERING COMMITTEE
Transportation Development Centre
British Columbia Transit
Alberta Transportation City of Edmonton
Ontario Ministry of Transportation
Canadian Urban Transit Association
Quebec Ministère des Transports
SENIOR BC TRANSIT MANAGEMENT
PROJECT DIRECTOR
BC Transit Project Management Committee
LEGAL/TECHNICAL SUPPORT
PROJECT COORDINATOR
TransVision Consultants Ltd.
OPERATING COMPANY #1
The Western Society for Senior Citizens' Services
Computer System Supplier #1
OPERATING COMPANY #2
North Shore handyDART Custom Transit Service
Computer System Supplier #2
CUSTOM TRANSIT OPERATORS AND USERS ADVISORY COMMITTEE
BC Transit Staff and Services

Exhibit 2: Project Organization in Edmonton



no training was required for these tasks. The planning Supervisor was given new duties immediately, including arrangements for building facilities and infrastructure, and liaison with the Mobile Equipment Services staff responsible for maintenance of the City vehicles. The planning Supervisor also acted as a Deputy Manager during the Brokerage Manager's absence. No formal management training was provided for either the Brokerage Manager or the Planning Supervisor when they assumed their new roles.

INVOLVEMENTS AND RESPONSIBILITIES

In Vancouver, three organizational entities were directly responsible for the implementation of the project: the project management team, the custom transit operators, and the development team. In Edmonton, two organizational entities were directly responsible for the implementation of the project: the City of Edmonton Transportation Department and the consultant project team. The consultant team also acted as the operator. In both cases, even though specialists and consultants were called on occasionally, their efforts were usually performed for the project management team.

Project management tools, such as activity logs and status reports, were used for monitoring and controlling the activity of all responsible parties. This control was exercised by the project team over the entire project. Tools for monitoring and controlling the activity of all responsible parties were used primarily by the Brokerage Centre Manager, in Edmonton, as means of reporting progress and problems to the civic administration.

The project management team, custom transit operator, and development team had specific areas of involvement and responsibility. These are discussed in the following sections.

Parties Involved in the Projects

The Project Management Teams. The project teams consisted of staff from BC Transit in Vancouver and staff from the City of Edmonton Transportation Department in Edmonton. Both teams possessed a variety of skills to guide the project from inception to completion, including: technical skills, applications knowledge, administrative skills, and leadership skills.

The project management teams' responsibilities were managerial rather than technical. In Edmonton, the project management team's main area

of responsibility also included operational aspects. In fact, the main concern of the project team was the successful operation of the brokerage system, including the control and direction of the scheduling/ dispatching staff. Due to this operational concern, it was difficult for project team members to divorce themselves from the daily activities (customer complaints, service problems) that are normally involved in operating a transit system; i.e., functional rather than project activities were often dominant in Edmonton.

Through project scheduling and tracking, the project teams ensured that all assigned resources were performed at the highest degree of efficiency. The project teams also solved problems, removed bottlenecks, and modified schedules to meet the dynamic project development environment.

The Custom Transit Operators. Because users ultimately determine the success or failure of any system, the custom transit operators were deeply involved in the development of the systems in Vancouver. They helped specify screen designs and functions, tested and reviewed the efforts, and were the approval authority -- while the project team advised and the development team performed the technical task.

In Edmonton, operator involvement was greatest during the initial phases of the development effort, when system requirements were defined. In Vancouver, after the initial definition effort, the operators regularly worked with, reviewed, requested changes, and approved appropriate products of the ongoing development effort.

The Development Teams. In a typical systems development effort, high-level technicians from the systems and programming areas translate user requirements into a working system. The development team in Vancouver -- SRI International and AIM Software Consulting -- was also responsible for the specifications, coding, testing, and implementation of the systems. In Edmonton, since an 'off-the-shelf' computer system was purchased, there wasn't any development effort or team. Productivity Systems Incorporated supplied a commercially-available computer software system for assisting in the scheduling and dispatching tasks.

The Consultant Groups. In Edmonton, the main concern of the consultant group was the successful operation of the brokerage system, including the direction and management of the service providers. Through daily operational monitoring of the assignment of trips to the service providers with careful attention to the costs involved, the team attempted to ensure that trip requests were being met in a cost-effective manner.

Since the consultant group was the primary user of the computerized scheduling systems and technology, there was no 'third-party' user group

involved in the design and development of the computer systems. This simplified the system development effort.

In Vancouver, the consultant group was a part of the project management team and was only concerned with the coordination and management of the demonstration project. The consultant was responsible for project control and coordination (preparation of status reports, minutes of meetings, etc.), advisory assistance (at various project meetings), and reporting and documentation (preparation of user manuals, on-line turorial programs, and final reports).

FUNCTIONS OF PROJECT MANAGEMENT

A useful project management methodology must address six key functions; all are interrelated, and the omission of any one affects the methodology's effectiveness. These six functions are: (1) Identifying and ordering tasks, (2) Establishing measurement criteria, (3) Organizing resources, (4) Providing a reporting mechanism, (5) Establishing a change procedure, and (6) Establishing an acceptance procedure. They are used to develop a work plan which is used to control the project.

In Vancouver, with a number of operators, consultants and suppliers involved in the project in disparate locations, a more formal project management methodology was deemed a necessity. Therefore, beginning with the detailed work plan and budget, other functions were undertaken using activity logs, regular project meetings and project status reports.

In Edmonton, due to the concern for the daily operations of the brokerage centre, formal project management efforts were not as obvious as in Vancouver. Although a detailed work plan was prepared at the beginning of the project, numerous changes in the direction of the project lessened the plan's value as a means of directing the project. The most noticeable change in direction was the change in status of the consulting group from the more typical project manager/consultant relationship to operators of the brokerage centre.

Project Control and Coordination

Reports. In Vancouver, status reporting was done on a regular, timely basis. This provided a record of progress that was used to detect performance trends and potential problems. The time and status reports reflected all the activities of the project team during the reporting period. The following information was included in the report: activities performed, activities planned, problems/lost time, and time to date.

The project coordinator collected this information, reviewed it, and posted the current activity to the monthly progress reports. If problems existed or were anticipated, the coordinator recommended whatever action was necessary be taken to correct the situation and prevent a recurrence, modifying the schedule when necessary. Problems that severely affected the time frame or project budget were reviewed quickly with the appropriate individuals to allow for a timely resolution.

In Edmonton, since the consulting group was involved in the daily operations of the centre, reporting tended to be on a more frequent and informal basis than would be the case with formal status reports. The Brokerage Supervisor, part of the consulting group, reported to the Brokerage Centre Manager. When the Brokerage Supervisor was not present, the dispatcher on duty, also part of the consulting group, was in charge of the dispatch office. Both the Supervisor and the dispatcher were located in the same building as the Manager and daily communications between them lessened the need for formal reports.

Meetings. Project review meetings were an integral part of the systems development process in Vancouver. Regularly scheduled review meetings were held with the project team to promote direct communication among team members. Team members would briefly review their efforts and problems and discuss items relevant to the project effort. In the meetings, team members were approached for solutions to problems, goals were established and reassessed, corrections were made. These meetings fostered a cooperative team effort.

In Edmonton, since the consulting group, as operators of the scheduling/dispatching centre, and the City's project management team were in almost daily contact, project review meetings also tended to be on a more frequent and informal basis. The operational nature of the relationship between the consulting group and the City's project team placed a burden on the project team in monitoring and controlling the project. Since the project team was also involved in the daily administrative aspects of the service, some project management activities were probably wanting.

4. APPROACH

A demonstration project is a well-defined effort undertaken to produce specified results in a given setting at predetermined times. Planning for such a project can be categorized in several ways. The basic objective of planning, however, is to develop an approach for actions and decisions that will ensure that the project's resources are effectively and efficiently acquired and used in support of the project objectives.

The tangible product of the planning process is a basic approach to the demonstration project -- a hierarchy of documented plans. The overall project plan states the goals and objectives, strategies and issues in the context of the understanding of the technological concept and the setting. It usually includes a work breakdown structure which provides a clear definition and division of work into manageable units. It includes a budget which is a detailed statement of planned actions (including the use of resources) for accomplishing the work and it includes a schedule which provides target dates for each work unit.

It should be noted that there were some major differences in the two projects. The Edmonton project focused on the implementation of the 'brokerage management system' initially and the new scheduling system later, while BC Transit's initial focus was on the software development and on 'coordination of services' later. Therefore, Edmonton's approach was more in line with a 'functional' approach -- implementation of various aspects of the brokerage system successively and in order. The Vancouver approach was essentially a systems development effort. The basic approach was to develop a computerized scheduling and dispatching system that would meet the requirements of the small special transit service operators in the area.

SYSTEMS DEVELOPMENT APPROACHES

Traditional Development Life Cycles

There are a number of systems development life cycles that organizations use in defining the steps in developing an information system. The number of steps varies widely but generally fits into the following framework:

- Feasibility Study -- determining the economic and technological advisability of initiating a new development effort
- Analysis -- ascertaining the functions of an existing manual system, defining and analyzing new functions required to enhance the process.
- Definition -- determining the software and hardware for the system, defining the logical structure and specifications of the applications.
- Development -- developing programs and testing, preparing training materials and user procedures.
- Implementation -- initiating activities for testing, training, and system installation; continuing maintenance and enhancements.
- Operation -- ensuring that the system meets operational requirements and is smoothly integrated into the environment.

Vancouver's Prototyping Approach

The use of prototypes was the approach that was used in Vancouver to ensure that the computer systems were tailored to the requirements, constraints and capabilities of the transit operators (see Exhibit 3). An information systems prototype is an early version of a system that exhibits the essential features of the later operational system. The prototype period begins once a function has been developed and tested for the new system. The software is installed as operational, but careful attention is given to the system users and their evolving understanding of their needs.

The basic reason for using a prototype is that it is easier to make changes to a system when it it not fully installed. The duration of a prototype depends on many factors, including application complexity and number of changes identified. The major benefits of using a prototyping approach include:

1) It provides the users with a tangible means of comprehending and evaluating the proposed system and elicits more meaningful feedback from users in terms of their needs and requirements. Users are extremely capable of criticizing an existing system but are not too good at articulating or anticipating their needs.

Exhibit 3: Project Development Approach in Vancouver

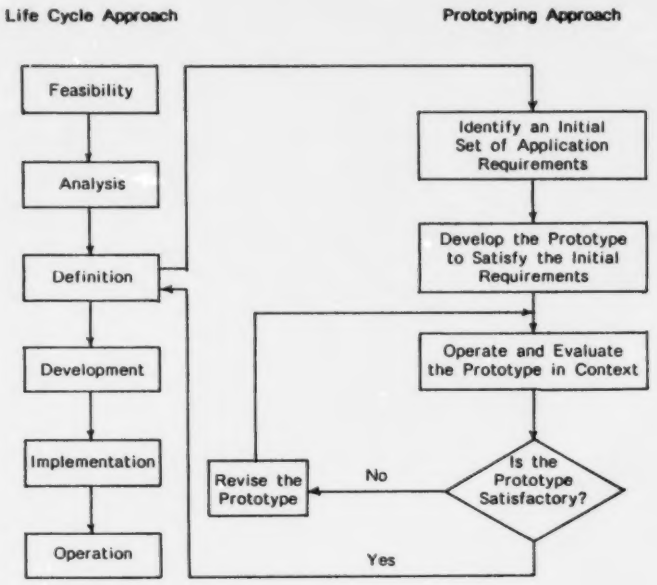
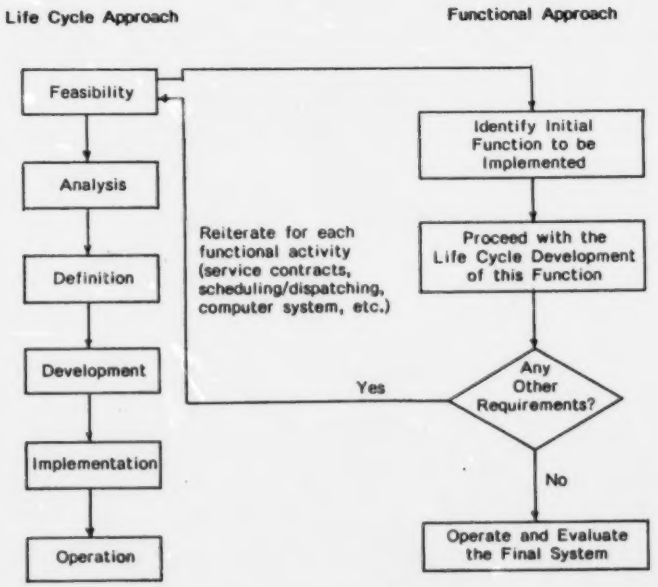


Exhibit 4: Project Development Approach in Edmonton



2) It provides a common reference point for both users and developers by which to identify potential problems and opportunities early in the development process. It is also an effective way to draw out and clarify user requirements.

3) It is a practical way to cultivate and achieve user participation and commitment to a project. Users and developers seem to develop better communication and rapport, and a better appreciation of each other's jobs. This in turn leads to a better working relationship between the two groups.

4) It helps ensure that the nucleus of a system is right (i.e. performs as expected or required) before the expenditure of resources for development of the entire system.

Edmonton's Functional Approach

Edmonton used a variation of the systems development life cycle. Although this approach (Exhibit 4) uses the same five phases as traditional development life cycles, deployment of the phases differed significantly. This variation is termed the functional systems development life cycle.

In the functional life cycle, each function can be implemented independently. After the first function (such as the service provider contracts) is implemented, the other functions pass through an additional development phase -- integration. The system therefore evolves as each function is integrated with its predecessors. The benefits of this approach include:

1) Functions are implemented as they are developed, in contrast to the traditional approach that results in waiting until all functions are completed. The user thus has part of the system to use earlier.

2) It is easier to define the benefits associated with each function, facilitating the validation of benefits once the function is implemented.

3) The sequence of function development can be easily established by using benefits and external factors. The sequence of priorities can also change readily to meet dynamic conditions. Setting priorities by functional benefits enables the largest percentage of benefits to be realized long before the entire system is completed.

4) The impact on the users caused by introduction of a new system is reduced when only one function is introduced at a time. The tasks of training and procedures development become more manageable. The users are able to adapt to the system more readily and can more easily cope with change.

The one negative effect must be emphasized: It is very difficult to manage a project using the functional life cycle. The two major sources of difficulty are multiple concurrent activities and the need for extensive communication among all personnel on the project.

APPLYING THE DIFFERENT APPROACHES

The purpose of both demonstration projects was to evaluate the brokerage concept as a means of achieving the coordinated assignment of trips to the most appropriate service option. In Vancouver emphasis was placed on the selection, implementation and demonstration of computerized systems, with particular emphasis on the best application of micro-computer technology to the personalized form of transportation offered by special services. In Edmonton, the testing of a computerized scheduling and management system appropriate to the trip assignment and control requirements of the brokerage system was a secondary concern.

In both cases, the overall project approach was one of incremental improvements to proven, operational systems in order to develop a computerized scheduling/brokerage system with minimum risk and maximum cost-effectiveness. In Vancouver, the computer system would hopefully promote optimum service delivery and the matching of supply with demand by establishing procedures for exchanging information between clients and operators through an intermediary coordinating computer network.

In Edmonton, more emphasis was placed on the primary objective of contracting with various service providers to provide the special transit service in the City. The administration structure and contracting arrangements would hopefully promote cost-effective service delivery and the matching of demand with the most effective service option. The general project approach was to implement the administrative structure, contract for the management system, negotiate contracts with service providers and get the system operating prior to the testing and evaluation of any computerized scheduling systems. Therefore, the administrative and management functions were implemented first, followed closely by the operational function and, finally, the computer scheduling function.

Vancouver's Selection/Development Process

In Vancouver, the general project approach was to obtain two proven computer software packages, install them at two selected regional custom transit operators and test and evaluate them over a period of time under normal operating conditions. After a period of testing and evaluation, one system would be selected (or developed from the components of the tested systems) for further expansion to the other five custom transit operators in the Vancouver area. At the same time, an attempt would be made to 'network' or provide a means of coordination and communication between the different operators.

Although it was proposed that two separate and different types of computer scheduling systems be obtained, it was anticipated that one of the systems would be integrated with the existing custom transit software that had been developed by BC Transit for the operator in the City of Victoria. This system provided computer assistance in the client registration and trip reservation functions of custom transit.

The general project methodology included the sequencing of activities and decisions leading to the definition, development, and implementation of computerized scheduling systems for custom transit services. A cyclical or iterative process was used to tailor the computer systems in relation to the requirements, constraints and capabilities of the transit operators.

In 1984 and 1985, BC Transit conducted an international search for computerized management and scheduling systems for special transit.

As a part of this investigation, BC Transit sent out a "Request for Expressions of Interest and Statements of Qualification" to various systems suppliers in 1984. After reviewing the responses and assessing the requirements of the custom transit operators, it was decided to implement a decentralized system oriented towards the application of microcomputers by individual operators in the Region.

Respondents to the previous Request for Qualifications who were able to provide a decentralized microcomputer-based scheduling system were invited to submit proposals for the supply and installation of either: (1) a computer-aided, or (2) a computerized scheduling system.

The 'Request for Proposals' outlined the general system requirements, specific proposal requirements and general terms and conditions for the supply of the proposed system(s). After reviewing the responses and selecting the systems with the best perceived value to BC Transit, negotiations were entered into with the system suppliers for the immediate implementation and testing of the systems.

The selection decision was based primarily on the need to keep both hardware and software costs affordable for small operators. Two software packages were selected, under the guidance of the steering committee, for demonstration.

The two systems were to be evaluated and then extended to all operators in the Vancouver region. A decision would have depended on cost (hardware, training, support), system reliability, ease of use, impact on management efficiency and on the quality of service provided to disabled people.

At the same time, an electronic network was to be examined in the brokerage phase of the demonstration project, to improve coordination between the seven custom transit operators in the region.

Edmonton's Contracting/Operating Process

Edmonton's approach was to contract for each of the individual functions separately. Therefore, the process involved tendering and contracting for: (1) the various service contracts, (2) the scheduling/dispatching function, and (3) the computerized scheduling system.

Based on the analysis of the service requirements conducted in the initial feasibility study (5), four distinct service options were identified and, subsequently, four distinct service contract specifications were drafted and tendered: (1) city-owned vehicles offering a many-to-many service, (2) city-owned vehicles offering a many-to-one service, (3) an hourly-charged sedan service, and (4) a flat-rate sedan (taxi) service. According to City of Edmonton policies and procedures, all service contracts were processed and tendered by the Materials Management Branch of the Real Estate and Supply and Services Department. All four contracts were advertised and tendered on a public basis. In all cases, the City accepted the lowest tender and contracts were entered into with the respective companies.

For the scheduling/dispatching function, the City of Edmonton entered into a contract with Louis G. Grimble Professional Engineer Limited who provided the staff and facilities to operate the dispatch centre during the demonstration project and until the operations could be absorbed by the City.

For the computer scheduling system, with an existing computer system, several courses of action were available to the City with respect to computerized scheduling options for DATS. These included: (1) maintaining the existing system; (2) improving the existing system; (3) obtaining a new system; and/or (4) developing a new system.

The third option was selected by the Brokerage Centre Manager as the best course of action based on the experience of the City staff with the previous contractor and initial experience with the existing scheduling system in the fall of 1985. Since that time some improvements have been made in the existing scheduling system which may allow this system to continue to be of use in a downloaded configuration. Still, obtaining a new system would provide DATS with an exclusive system controlled by DATS personnel and one that would probably be better suited to the management needs of the brokerage concept.

Draft specifications were supplied for the new scheduling system by a specialist consultant in June 1985. These were reviewed and revised by city staff, and tenders initiated in December 1985. Three firms submitted proposals: (1) Comshare Limited (latter PSI), Toronto; (2) SRI International, California; and (3) Giro Incorporated, Montreal.

These proposals were evaluated in several areas: (1) technical merit of software; (2) cost of software, hardware, operation; (3) applicability to

brokerage framework; (4) political saleability, (5) implementation schedule; (6) existing applications; and (7) universal potential. The evaluation used the existing City of Edmonton scheduling system as a base line for all comparisons.

The proposals had to address and conform to the functional specifications as stated in the proposal call, which were as follows:

> "The required computerized scheduling system must facilitate efficient client registration, trip reservation, trip scheduling, and vehicle dispatching functions for a number of independent contractors utilizing sedans, passenger vans and lift-equipped vehicles. The system must allow for the most effective matching of supply and demand."

The proposal by Productivity Systems Incorporated (PSI) was selected as the least expensive proposal providing a system capable of improving the existing reservation and reporting functions. The implications, however, of depending on manual scheduling or running the PSI system in link with the existing scheduling algorithm did not include costs for transferring the existing data base. When these costs were included (transferring the data base and using manual scheduling), the benefits of the PSI system were considerably reduced. Practicality was also a major concern and a simple bookkeeping system like the PSI system was considered to be advantageous when compared to the previous Ellis system. From the Edmonton point-of-view, this approach appears to have worked fairly well.

Computer hardware to accommodate the new system was acquired by the City early in 1986. The new PSI scheduling system was proposed to be implemented in September 1986; however, renovations to the office space delayed the installation until October 1986.

5. TECHNOLOGY

Computers can have an enormous impact on both the quality and speed of information flows within the management and operation of a custom transit office. Considerable work has been undertaken previously in developing the role of the computer for performing information storage and transmission tasks, as well as in the generation of system statistics.

Computer assistance should enable the custom transit office to attain the following objectives: the elimination of redundant and unnecessary tasks such as copying of information; better utilization of human resources of tasks that require judgment, initiative and analysis; faster, better decision-making; and better exploitation of the unique capabilities of custom transit office workers. The extent to which the computer can aid in the decision-making process involved in scheduling is a more complicated issue. But it is in this area where the greatest benefits are anticipated. Matching the supply of available vehicles with the demand for trips and making the most effective use of limited resources are the challenges faced daily by managers of special transit services.

In the Vancouver region, two microcomputer software packages were tested by two different custom transit operators in their daily operations. These packages were 'public domain' and they attempted to provided assistance in the scheduling function, as well as assisting in information storage and transmission. Later phases of the project were to involve the extension of microcomputers to the other operators of special transit in the region and the coordination of information-sharing between operators via an electronic network. In Edmonton, an existing minicomputer scheduling system was abandoned for a proprietary microcomputer software package that essentially provided only a bookkeeping function.

COMPUTER SYSTEMS IN VANCOUVER

Based on the conclusions resulting from the feasibility analysis and on a requirement that systems be easily transportable to other special transit operations in Canada, it was decided that the software should be developed for the IBM PC and compatible class of microcomputers.

Two systems were developed -- one for multi-user systems and one for local area networks. Both systems are computer-aided scheduling systems. They provide an aid to the decision-maker by displaying information necessary to assist in the decision process, but do not actually make any decisions. One system uses a tabular display of the vehicle schedules and the other uses both tabular and graphical displays.

DART Manager Plus

BC Transit's Dial-A-Ride Transit Manager (DART Manager) was chosen for use in the New Westminster-Burnaby-Coquitlam suburban area. BC Transit had developed this computerized registration, trip reservation, and management information system starting in 1983 in Victoria. By 1986, it was in use in six British Columbia cities.

Because the test operator, the Western Society for Senior Citizens' Services, employs 16 vehicles, the software was modified to operate on a multi-user microcomputer system with two or more terminals, using a Xenix operating system. The second version of the software, the DART Manager Plus, also adds some improved scheduling features, adding full schedule information to the software through the display of a scheduling screen showing vehicles and vehicle assignments for each day and time period. Easy keyboard strokes allow managers to check on vehicle status and instantly assign passenger trips.

The major functions in the system can be divided into two categories: client registration/trip reservation and operations monitoring. Although the actual scheduling of trips is a manual procedure, the system assists in storing, retrieving and displaying client registration/trip reservation information (e.g. client information, trip requests, daily trip sheets) used to assist the scheduling process. The operations monitoring function assists in analyzing daily trip logs and producing vehicle statistical summaries and performance reports. The following sections provide a brief description of the major system functions:

Client Registration. The client master file contains all of the pertinent personal information on each registrant including a registration number

that is automatically generated by the computer. There are currently 2,800 persons registered to use the service provided by the Western Society with 25-50 new clients being added each month. The computer provides rapid access to the registration data by either client number or name. It also insures that everyone who uses the system has been registered. Information can be added, deleted or changed easily.

Trip Reservation. The system provides several trip reservation functions: (1) subscription trip requests, (2) advance booking trip requests, (3) cancel, change or query trip, and (4) display trips currently booked for a client. The trip reservation system is designed to require a minimum user input of information. In the trip request procedure, the user enters the client's registrant number or last name which produces a split screen display of registrant and trip information. The computer prompts whether the trip is outgoing or incoming. If the trip is outgoing, data from the registration file, (e.g. name, origin address) is used to supplement user input. On incoming trips, data from the previous trip is used (e.g. pickup and dropoff addresses). The use of a trip expiry date allows input of both subscription and reservation type trips. The system can be purged of all trips that have expired. As well, the start and stop dates of a subscription trip can be input in order to temporarily suspend a trip. This is useful when a trip is cancelled for awhile due to illness or vacation.

Scheduling Function. The original Victoria System did not actually 'schedule' trips. As subscription and advance booked trip requests were entered into the system, a trip ticket was printed containing information for scheduling used in conjunction with a trip scheduling board. Each 'board', representing a day of the week, was organized by vehicles (columns) and 30-minute time slots (rows). The boards provided the scheduler with an at-a-glance summary of vehicle loads by time of day. After the trip was scheduled, the assigned vehicle number for the trip was entered into the computer to allow the printing of daily trip sheets.

The major modification with the DART Manager Plus was the display of the trip scheduling board on the screen. The screen provides a summary of vehicle activities. Within each time slot for each vehicle, the screen displays the number of passengers and location by zone of the vehicle. The operator thus has the information necessary to assign trips to vehicles and can easily scroll through the list of vehicles or transfer between screens (from trip booking to trip assignment). After trips are assigned, daily trip sheets for the drivers can be produced.

Report Generation. There are several reports that can be produced. On a daily basis, the Delete Subscriber and Daily Trip reports are produced. The Daily Trip Report contains the information necessary for the drivers to proceed with their daily run. Daily, monthly and year-to-date reports on vehicle statistics (ridership, hours, kilometers, etc.) are also available. Several other reports, providing a listing of disability and zone codes and their descriptions and common addresses, are also available. Another

report, Client Statistics, groups clients by disability and zone as well as providing a breakdown by trip type. The system is also capable of printing mailing labels by either zone or registration number.

Operations Monitoring. During and at the end of each day, the trip file is updated to reflect what actually takes place on the road. After information on fuel usage, distance travelled and shift time is added, the computer has all the necessary information to produce the monthly statistics report. Vehicle and system information is available by day, month and year-to-date. The statistical reports provide information for compiling vehicle schedules and for planning and monitoring purposes.

A monthly report on the daily productivity of each vehicle provides a comparison of vehicle utilization. The supervisor is able to adjust schedules based on this information to ensure that all vehicles are well utilized. A comparison of vehicle kilometers and passengers carried provides the drivers with an indication of workloads. The breakdown of ridership by vehicle by day assists in the allocation of trips to vehicles. A report on the fuel efficiency of each vehicle highlights major deviations and possible mechanical problems.

Software. DART Manager Plus is written in RM-COBOL, a standard business application language. Many other computers are capable of running the custom transit program with very little or no modifications. The application program must be recompiled on the new computer.

IBM PC Environment. DART Manager Plus runs on any IBM PC, PC/XT, PC/AT, or 100-percent compatible running under XENIX or DOS 3.1 with 384KB to 640KB of RAM and one floppy drive and a hard disk. The system can keep vehicle schedules for up to 64 vehicles.

DART Manager Graphics

A colour graphics scheduling system developed by the Stanford Research Institute of California for the United States Urban Mass Transportation Administration was selected for testing in the 20-vehicle custom transit operation serving the City of Vancouver. As a result of a restructuring of services in the area and a change in size of the selected operator (i.e. from 20 to 50 vehicles), this system was subsequently moved to the North Shore and installed at the 7-vehicle North Shore handyDART service. Originally designed to use a local area network, the smaller North Shore operation only required a single-user version.

The heart of this software is an interactive computer-aided graphics display for vehicle scheduling of both real-time and advance-reservation trips. Like DART Manager Plus, DART Manager Graphics handles client registration, passenger reservations and management reporting functions. The colour graphic display of vehicles and trips overlaid on a service area

map gives both time and distance information at a glance. By providing immediate feedback on the impacts of alternative trip assignments, it helps managers make scheduling decisions.

Data Base Structure. Each real-time process runs as an independent program under the jurisdiction of the operating system and communicates with a shared set of files. The largest files include: regular subscription trips for each day of the week, a dated file that is produced by copying the subscription file and adding advance trips, and a daily file that also includes any demand trips for the day in question.

Order Taking Module. The order taking system is designed to require a minimum of operator input and to prevent errors and confusion. At every command level, a menu of possible options is displayed. A single character suffices to select a command. When entering data, the user cannot overwrite protected fields on the screen and is warned by messages if the input is unreasonable. At every stage it is possible to abort what one is doing and to escape to the next highest command level.

The order taker interacts with the monochrome monitor and the keyboard. A standard order taking form is displayed at the terminal. The order taker enters the caller's phone number and name, pickup and dropoff addresses, number of passengers, and any special remarks. The pickup and dropoff address are converted to x-y coordinates using an address translation file based on a map coordinate system. Return trips are booked by pressing a 'duplicate address' function key to reverse the origin and destination of the trip.

Scheduling Module. The scheduling subsystem displays the primary information including such key data as pickup and delivery sequence, vehicle assigned, and location of vehicle, for all requests and vehicles that are to be scheduled in the current time frame. The scheduler makes decisions based on the spatial and time information provided by either the textual or graphical display. The secondary information including such data as number of passengers and vehicle capacity is important, but the scheduler does not refer to these data for all scheduling decisions, leaving it to the computer to keep track of.

The location of the pickup and delivery stops, promised pickup and delivery times, and the passenger's use of a wheelchair is provided by the order taking function. The scheduling subsystem automatically checks vehicle capacity and calculates and updates the estimated pickup and delivery times for all requests.

A static scheduling procedure may be used when all the requests for service are known at least a day in advance -- then a 'fast' function can be used to schedule the trips. If only a few requests are known in advance, they are easily handled one at a time with either the keyboard and the textual display or the mouse and the graphical display. The use of the

mouse and the graphical display permits the scheduler to test a number of different assignments quickly and easily to ascertain the best assignment. The assignments are not saved until the 'finish' function is enabled.

Dispatching Module. Both a stop list (for the dispatcher) and a trip sheet (for the driver) are produced after all the scheduling assignments for the day have been made. The dispatcher can interact directly with a dispatch display, a monochrome monitor, and the keyboard. The dispatching screen displays the stops for each in-service vehicle, including the address, arrival time, and number of passengers to be picked up or dropped off. The first field indicates the vehicle number for the information displayed. The second field is used to indicate if the vehicle is new in service, if any of the stops are new, of if the vehicle should go out of service at a stop, if a 'W' appears after this field, it indicates that the customer requires wheelchair assistance. This information can be relayed to the vehicle by the dispatcher via two-way radio, telephone, or other communication. The dispatcher can also use this screen to enter the vehicle's arrival at a scheduled stop. The arrival time and number of passengers picked up or dropped off are automatically written to a file to be read by the scheduling subsystem.

The dispatching function is divided into three independent functions. One is to relay information from the dispatching display to the driver, another to relay information from the driver, and the other to maintain vehicle status data.

Management Information System. The computer can produce several types of management information reports. The basic input for all reports is collected automatically by the order taking, scheduling and dispatching functions. These reports are produced using information obtained from the log of all the daily transactions. A standard set of MIS programs was developed. The MIS programs are written in dBase III Plus so that (1) they can be easily adapted to an individual site's requirements, and (2) individual ad hoc reports can be easily produced. The standard reports produced by the MIS programs include: a daily operational summary, a monthly operational summary and a monthly operator's invoice (for billing a funding agency). The information used in producing the reports is derived from the booking, scheduling and dispatching functions and corrected, where necessary, from the individual trip logs.

Software. DART Manager Graphics has been written in Microsoft Pascal using a number of procedures from the Turbo Pascal tool-kit. Pascal is a common language with a large following among programmers ever since Turbo Pascal became so readily available for microcomputers.

IBM PC Environment. DART Manager Graphics runs on any IBM PC, PC/XT, PC/AT, or 100-percent compatible running under DOS 3.1 with 640KB RAM and one floppy drive and a hard disk. It can also be used with a local area network (e.g. Novell software and 3-Com hardware).

Exhibit 5: Computer Systems in Vancouver

DART MANAGER PLUS	DART MANAGER GRAPHICS
IBM PC DOS Single User Environment or IBM Xenix Multi-User Environment	IBM PC DOS Single User Environment or Local Area Network Multi-User Environment
Code is written in RM Cobol Not available to the user	Code is written in MS Pascal Not available to the user
User interface is Menu-driven with some special key commands	User interface is Menu driven with on-screen function key commands
Scrolling screen for scheduling assistance	Graphics or textual screen for scheduling
Scheduling assistance provided by screen display of vehicle schedules, eight vehicles at a time for a two-hour period	Scheduling assistance provided by colour graphics display or monochrome time-ordered display of schedules for selected time
Suitable for up to 64-vehicle fleets	No limitation but most suitable for less than 64-vehicle fleets
Maximum of 3 terminals for multi-user configuration	No limitation on number of workstations in LAN
Public Domain Software	Public Domain Software

Exhibit 6: Computer Systems in Edmonton

DATS SCHEDULING SYSTEM	PSI SCHEDULING SYSTEM
Hewlett Packard 3000 Multi-User Environment	QNX Multi-User Environment
Code is written in Fortan Not available to the user	Code is written in ZIM Not available to the user
User interface is Menu-driven with some special key commands	User interface is Menu driven with on-screen function key commands
Automatic trip insertion algorithm for scheduling	Time-ordered printout of trips for scheduling
Automatic scheduling provided by trip insertion algorithm that offers three suggestions for inserting trip in schedule	Scheduling assistance provided by time-ordered printout of trip requests to which a vehicle number is assigned manually
Suitable for up to 100-vehicle fleets	Suitable for up to 100 vehicle fleets
No maximum of terminals for multi-user configuration	No limitation on number of termi- nals in multi-user configuration
Proprietary Software	Proprietary Software

COMPUTER SYSTEMS IN EDMONTON

Based on information from the review of the existing scheduling system and on the experience with its use in the new brokerage centre, it was decided that the City should investigate alternative systems.

A proposal by Comshare Limited of Toronto (now PSI Incorporated) was selected. The PSI proposal was selected as the least expensive proposal providing a system capable of improving the existing reservation and reporting functions. After the system was installed, the source code was purchased by the City so that they could undertake modifications deemed necessary for the operation of the system

Two computer systems were thus used and tested in Edmonton for the brokerage centre: the DATS computerized scheduling system developed in 1981-82 and the new PSI computer-aided system which was implemented in late 1986. Manual systems were also used during the project.

DATS Scheduling System

The previous dispatch and scheduling system for DATS utilized a semi-automated reservation system and an automated scheduling feature using a trip insertion algorithm (i.e., the trip was inserted into an existing 'master' schedule of regular subscription trips). This system was developed for the City of Edmonton by D.W. Ellis & Associates Limited.

Initially, since the system was already in place, all scheduling was undertaken utilizing this scheduling system. The automatic scheduling computer algorithm ran on an HP3000 computer owned by the Transportation Department in the City of Edmonton. The brokerage centre was linked by modem to the HP3000 which was located in Edmonton Transit offices. The Transportation Department provided technical support.

The scheduling and dispatching operations were a mix of manual and computer systems. All trips, whether reservation or subscription, were recorded on a card file system. Colour-coded cards were used to distinguish between ambulatory patrons and non-ambulatory patrons: white for ambulatory and pink for non-ambulatory. The colour coding was used to assist in segregating trips which could be assigned to the various services.

The subscription trips were maintained in a separate card file which was always available to the schedulers and dispatchers. The subscription trips were also maintained in a permanent form on computer which provided the automatic scheduling function.

Client Registration. All patrons registered were on file in the computer data base. The computer data base maintained information on all individuals and recorded their permanent subscription trips as well as any current reservation trips.

Trip Reservation. All trip booking was done through call-taking staff at the Brokerage Centre. Details of the requested trips were recorded on the file cards by the call-takers. Terminals were available to the call-takers to display pertinent information on each patron. Call-takers would, as a matter of routine, call up information about the user on the terminals to assist in completing the reservation or subscription trip request. This permitted the call-taker to confirm correct information with respect to user number, name, home address, etc. The completed trip cards were then provided to the scheduling staff.

Scheduling Function. A master schedule, which consisted of a series of routes with subscription bookings for every day of the week, was maintained on the computer system. One scheduler was devoted on a full time basis to maintaining the master schedule. On average, approximately fifty changes per day were made in the master schedules and in peak periods in October and January approximately 80 to 100 changes were introduced per day.

Once a master schedule had been completed for a specific day of the week, other reservations for that day's service could be entered in the computer for scheduling. Most subscription trip changes required a minimum of one week's notice. Reservations could be booked up to 48 hours in advance.

Two staff schedulers were assigned to preparing daily schedules. One scheduler was responsible for scheduling the wheelchair patrons and the other was responsible for the ambulatory patrons. Trips were entered into the computer and an assignment made by a scheduler from the alternatives generated by the automatic scheduling algorithm. Any trips which did not fit within the constraints set out by the automatic scheduling algorithm were set aside and assigned a 'no-fit'. All no-fits became the responsibility of the dispatcher on the day of service to be allocated to a specific run as circumstances permitted. Once the scheduling algorithm had confirmed a pickup time, the user was called back to confirm the 'window time' when they could anticipate the DATS vehicle arriving to pick them up. A one-half hour 'window time' was used.

A scheduling allocation procedure was used in which all wheelchairs were scheduled to the capacity of the van service and all ambulatory patrons were scheduled to the capacity of the sedan service. Any ambulatory trips which could not be accommodated were then assigned to taxis.

Trip Dispatching. Once a current day file had been created by duplicating the master file schedule for that day and then incorporating reserva-

tion trips, a hard copy in duplicate was printed out the evening before the day of service. Last minute changes, including cancellations and additions, were made on the printout by the dispatcher prior to pickup by the drivers. One copy of the printout as amended was given to the drivers when they reported to work. The second copy with amendments was retained by the dispatcher on duty for ongoing verification. Further changes required during the operating day as a result of user or system changes were made by radio communication with the drivers or through the telephone to dispatchers for the sedan and taxi services.

The automatic computerized scheduling algorithm was used only for the van and sedan contracts. The computer generated time-ordered schedule of pickups and dropoffs for the drivers to follow. The taxi contractor was provided with a time-ordered list of pickup time of all required trips for a day. Initially, this list was generated manually, but later was generated using a sorting program on the HP3000. This list was made available to the taxi contractor the evening prior to the day of service.

The many-to-one service to the A.C.T. Centre was scheduled manually. One of the reasons for a manual scheduling system was that many of the patrons were not DATS registered users and therefore not part of the computer data base. Eligibility for use of DATS for A.C.T. was based on registration in an A.C.T. program.

Dispatching aids were limited to hard copies of all scheduled runs, the computer client files with daily bookings for each client, and a hard copy of each reservation for the day. The minimum staff complement to operate the above system is one senior scheduler with primary responsibility for the master schedules, two assistant schedulers responsible for reservation scheduling, plus three call-takers during peak periods and a dispatcher on duty for all operating hours.

Due to a number of problems with the DATS Scheduling system (8), most notably a lack of management reports, a new system was obtained.

PSI Scheduling System

Computer hardware to accommodate the new system was acquired by the City early in 1986. The new PSI scheduling system was proposed to be implemented in September 1986; however, renovations to the office space delayed the installation to October. Since the software did not fully satisfy the City's requirements, the City purchased the source code for the program so that a number of modifications could be made internally.

The PSI software was originally developed for the Hamilton special transit service. The system does not utilize a scheduling algorithm, but relies on manual scheduling decisions utilizing the sorting capabilities of the computer to order the trips in the manner selected by the scheduler.

This system, because of its different scheduling process, required changes in the management system, functions of the staff members, as well as in the operating and user policies.

Without the aid of a scheduling algorithm to provide continual adjustments to the schedule to fit trips into the master schedule, scheduling cannot be done incrementally but must be done once all the trips are known. Therefore, a cut-off time for reservation trips was required to permit the scheduler to display all the trips scheduled so that reasonably efficient routes could be determined. With the former scheduling algorithm, reservations were cut off at 5:30 pm of the day prior to the day of the trips.

The selection of the cut-off time had implications for both scheduler and user, with the scheduler preferring as much advance notice as possible and the user preferring to delay as long as possible. For example, the system in Hamilton had established a 10:00 am cut-off time the day before the trip to permit the scheduler to develop schedules during the day. Any reservations received after 10:00 am were treated as demand reservations on a space-available basis. Similarly, Edmonton had to initiate a 1:00 pm cut-off time the day prior to the actual trip to allow the schedulers time to develop the schedules for the day.

The second concern was the staff required for scheduling. The existing scheduling staff requirement reflected the slow response time of the algorithm. With a faster computer source, staff could be reallocated. The scheduling staff required for the PSI system was a function of: the capacity of the individual to manually handle reservation requests; and the detail to which the scheduling must be done. The number of routes and the number of reservations which an individual may be able to handle in one shift was difficult to evaluate. It was estimated that three schedulers would be required for current scheduling plus one for master scheduling. With three schedulers handling the current schedule, a method of allocation of trips among the schedulers was required. As well, some way to assign buses to serve actual demands was required.

Although the PSI system does provide for storing reservations electronically and permits very fast processing time for information requests, it does not provide for any way to establish schedule times. Without the scheduling algorithm function to assist in assignment of pickup time, some pickup times must be established at the time of reservation to create a basis for the scheduler to sort the data file.

Data Base Structure. The database consists of four main files. The client file contains information on each of the registered clients such as identification number, address and most frequent destinations. The booking file contains all the irregular bookings that the clients have requested. The master schedule is the third file, containing all the regular subscription bookings for clients. The fourth file is the current schedule (or today) file containing all the requested trips for the current day.

Client Registration. The necessary information on each eligible client is entered into the system by filling in a form on the screen. In addition to the normal information on name and address, three common destinations for the client can be entered and kept available for use during the trip booking function.

Trip Reservation. The call-taker is guided by the form on the screen to collect the necessary information with respect to trip requests. Special codes are used to describe the type of disability and special requirements of the client. Information for the return trip is derived from the originating trip.

Trip Scheduling. As mentioned in the preceding paragraphs, the system prints trip lists sorted by time to assist the scheduler in assigning trips to particular vehicles. The vehicle numbers are then re-entered into the computer so that the trip request will be printed on the appropriate driver run sheets.

Management Information. A number of management information reports can be produced with the system, including monthly accounting statistics to aid in invoicing agencies which subsidize certain clients. Monthly and year-to-date reports are provided. Other reports include: inactive user reports, specialized reports on system performance and trip statistics by type and by contractor.

Software. The software uses a multi-user operating system called QNX (Version 2.05 by Quantrum Software Systems) and is developed from a data base management system called ZIM (Version 2.53 by Zanthe Information Systems).

Hardware. The PSI system operates on a multi-user system of six remote terminals plus one console terminal. The Esprit 630 terminals are linked to one Compaq Deskpro 286 with a 70Mb hard disk for scheduling and dispatching functions. A second Compaq 286 with a 30Mb hard disk is used to maintain client registration files.

6. IMPLEMENTATION

Systems implementation includes all activities that occur during the actual installation of the systems and generally involves new equipment, programs, work methods, and user responsibilities. The task of systems implementation is generally a major undertaking, resulting in a requirement for some implementation planning.

A logical starting point for this type of planning involves knowledge of the following areas: personnel needs, programming, documentation, controls, equipment, physical requirements and conversion activities. An understanding of these areas establishes the specific tasks that must be undertaken and the relationship among them. This background permits detailed planning of the implementation process.

In Vancouver, the implementation process was essentially a system development exercise -- the development, implementation and testing of computer systems. In addition, the computer systems were implemented within the existing office environments. The Edmonton demonstration project was more comprehensive and included the organizational and operational aspects of a special service, as well as the scheduling and dispatching functions. The implementation strategy was therefore quite different from the Vancouver project.

The major concern in Vancouver was for the transit operators who were the users of the system. A prototype approach was used to provide the users with an opportunity to provide feedback. In Edmonton, the major concern was for the organizational structure and the selection of service providers before the scheduling and dispatching functions were implemented (partly because a computer system was already functional).

THE IMPLEMENTATION PRIORITIES

In Vancouver, the development of the individual computer systems for the custom transit operators received priority. The brokerage aspect -- the networking of the individual computer systems -- was delayed until the computer systems proved successful. The major steps in the implementation process were preparatory work for the new systems, the equipment acquisition and installation, the actual systems implementation, systems testing and acceptance, user training, and the operation of the new systems. A holistic approach to implementation was used to ensure that systems would be used successfully by the transit operators. The project team worked intensely with the custom transit operator end-users.

In Edmonton, priority was placed on the creation of the brokerage organizational structure. The major steps in the implementation process included obtaining approval from the civic administration, tendering for the operation of the various services, tendering for the supply of the computerized scheduling/dispatching system, staff training, labour relations and the operation of the new systems. In Edmonton, the implementation approach was oriented more toward the total service than the individual parts. In fact, the major consideration was for the organizational structure within which the various parts were to function.

Brokerage Organizations

In Edmonton, it was necessary to create an organization within which the staff who carried out the scheduling functions were accountable only to the City for the use of the most appropriate and cost-effective mix of service providers. In the initial feasibility report, several alternatives were assessed: one based on establishing a separate civic department and one based on a contract arrangement. In both alternatives, the brokerage centre would be responsible for scheduling and dispatching all services.

Due to the need for flexibility during the initial demonstration, the contract arrangement for the organizational structure was selected. This arrangement provided for testing of alternative staff responsibilities and dealing with the new conditions with more flexibility than possible within a public administrative structure. The contract arrangement established a Brokerage Supervisor under contract responsible for the scheduling and dispatching functions reporting to a Brokerage Centre Manager. The Brokerage Centre Manager was a City employee in the Transportation Department who was responsible for the overall administration including management of the service contractors and administrative tasks such as registration of users, customer relations and service planning.

In Vancouver, the existing organizational structure was left unchanged. The major concern was to try and fit the new computer systems to the custom transit operator end-users. The first step in undertaking the systems implementation in Vancouver was the selection of the operators that would use the computer systems during the demonstration project. A number of factors were used to select which operators would be involved, including size and location; but, probably the most important factor was the interest of the operator. The operators had to be receptive.

Rather than a centralized brokerage centre for coordinating services, a decentralized approach to coordination was planned. Prior to the demonstration project, the operators tended to coordinate their services to a degree just by telephoning each other to exchange information with respect to services. The concept behind the Vancouver approach to coordination was to provide an electronic communications network and appropriate software for greater and easier information-sharing. The goal was to allow the operators to actually book trips for their clients on other operators' services or to see what other services might better meet the needs of their clients trip requests -- especially for trips that might cross a couple of zones. Although a number of software products were found that would allow this information exchange, none were actually tested during the demonstration project.

Computer Systems

The process involved in selecting the computer systems and suppliers for the Vancouver project was a formal Request for Proposals process which was issued in May 1985. In August 1985, contracts were awarded to AIM Software in Victoria to develop a multi-user version of the DART Manager and SRI International for a systems analysis of one of the proposed custom transit operators. These were the first steps in the systems development process. In November 1985, based on the results of the systems analysis, a contract was awarded to SRI to develop the DART Manager Graphics. In January 1986, a contract was awarded to AIM Software to develop an enhanced version of DART Manager that would include the computer-aided scheduling function. Both systems were not considered fully operational until March 1987.

In Edmonton, the official contract for the computer system was awarded on March 19, 1986 and work to customize the computer-aided scheduling system supplied by PSI initated April 23, 1986. It was scheduled for implementation in June 1986 with operations to begin after Labour Day in September. Due to a number of small problems during the installation, operations did not begin until October 22nd. Formal acceptance tests were conducted on November 17th. As a result of the acceptance tests, the source code for the program was obtained by the City and internal staff used to make the necessary adjustments to the program to meet the specific needs of the brokerage centre.

UNDERTAKING THE SYSTEMS IMPLEMENTATION

Edmonton Service Contracts

Obtaining approval by City Council was the first step in the implementation process in Edmonton. Upon approval by City Council, the tasks of establishing the brokerage operation were undertaken. The first major task was the tendering process. A complete tendering for the delivery of services was required, incorporating the terms and conditions needed for operating the brokerage. Since the contracts were between the contractor and the City of Edmonton, the normal tendering procedures of the City had to be followed. The following contracts for service were prepared for tender:

1) provision of drivers on an hourly basis for city-owned lift-equipped vehicles operating a many-to-many service (CT#1)
2) provision of drivers and vehicles on an hourly basis for peak hour service for ambulatory patrons (CT#2)
3) provision of drivers and vehicles on a per-trip and shared-ride basis for ambulatory patrons (CT#3)
4) provision of drivers on an hourly-rate basis for city-owned vehicles operating a many-to-one service (CT#4)
5) provision of scheduling and dispatching staff to the brokerage centre for the period of the demonstration project (CT#5)

The first four packages were advertised and tendered on a public basis. A public opening of the tenders received was held June 27, 1985. In all cases, the City accepted the lowest price tendered and contracts were entered into with the respective companies. The fifth contract was awarded to L.G. Grimble Professional Engineer Limited, the consultant for the project.

Tender Provisions. The initial feasibility studies and previous contract experience lead to the incorporation of a number of key elements into the tender documents. The more significant elements included: a stipulation that the contracts would be a non-exclusive right to provide drivers for a portion of the DATS service; a minimum hours of service guarantee; cancellation clauses for non-performance; a definition of the relationship between the scheduling and dispatch operation and the contractor; conditions related to liability and insurance; conditions related to the quality of the vehicles when supplied by the contractor; and where a per-trip taxi service was supplied by the contractor, the tender specified payment based on a rate per trip per number of zones crossed from origin to destination, and did not specify a minimum number of trips.

Exhibit 7: Implementation Process in Vancouver

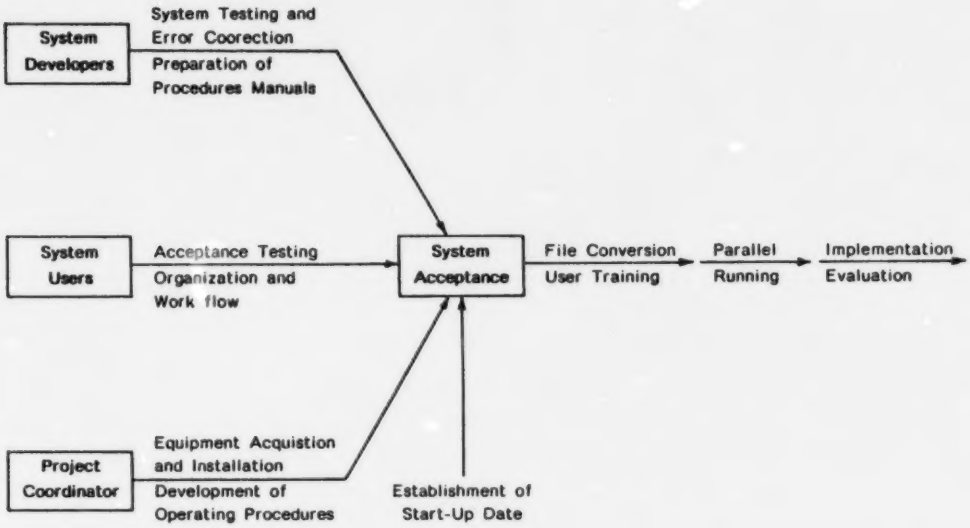
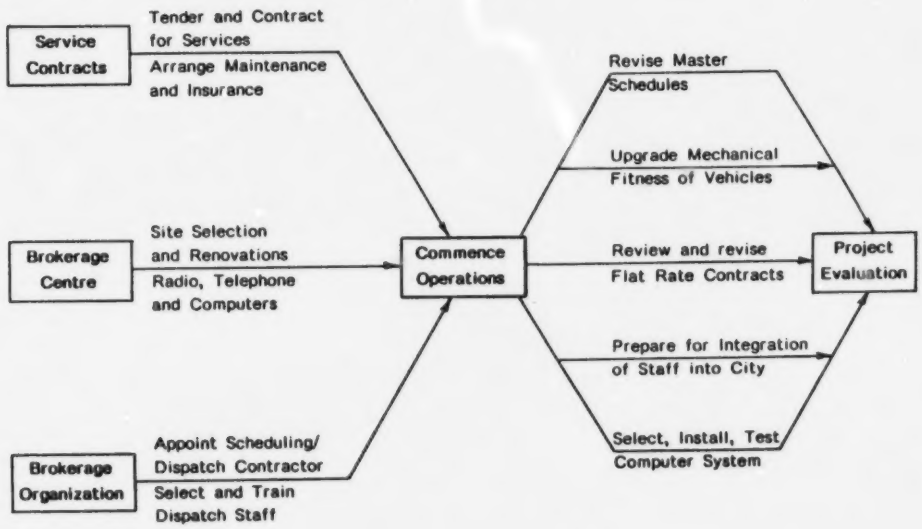


Exhibit 8: Implementation Process in Edmonton



Edmonton Brokerage Centre

Because the City had previously contracted DATS service, including maintenance and scheduling, the implementation of the Brokerage Centre required the establishment of a new facility for new operation.

Site Selection. A number of criteria were important in the selection of a site for the Brokerage Centre: location, costs, vehicle facililities, proximity of Mobile Equipment Services (MES) depots, wheelchair accessibility. Three sites were examined to determine their feasibility for adaptation to the purposes of the brokerage centre. The selected site was located in the southeast area of the City. This site was a newer City facility that did not require any adaptation to meet the needs of disabled persons. It was unused for other purposes and it was located adjacent to an existing Mobile Equipment Service Depot.

Vehicle Maintenance. Internal negotiations were carried out with the City's Mobile Equipment Services (MES) division of the Central Supply and Services Department regarding the maintenance of City-owned vehicles. A flat rate on a mileage basis by age of vehicle was established for fuel and maintenance, and arrangements were made to inspect and repair all vehicles as needed.

Telephone System. One central telephone number was assigned for all user needs, including reservations, cancellations and information. The central number was chosen as opposed to a multi-number system in which specific numbers would be assigned for specific purposes. A key consideration was the simplification from the users point of view. A six-line rotary system was installed. Additional lines were installed for administration and dispatching purposes.

Radio System. A radio communication system was required for dispatching of the City-owned lift-equipped vehicles. The least-cost option was the purchase of existing equipment from the previous contractor and the arrangement with the Federal Department of Communications to transfer the assigned transmission frequency. Additional radios were supplied by the City, including two hand-held units.

Office Equipment. The existing dispatch office files and the furniture that was specially constructed to hold the computer terminals and radio equipment were purchased by the City from the former contractor. Surplus office furniture was drawn from several City sources for the administrative offices. New furniture was purchased for meeting rooms and the staff lunch room. The operations contractors furnished their own offices within the Brokerage Centre. City-owned computer equipment was relocated from the contractor's offices along with the purchased furniture and radio equipment on the evening of July 31, 1985 and was in service the following morning. Additional used computer terminals were obtained from the Computer Systems section of the Transportation Department.

The brokerage centre operation began on August 1st, 1985 with the existing computer system. On October 22nd, 1986 operations began with the PSI computer-aided scheduling system. On January 1st, 1987 the contract brokerage staff were absorbed into the civic administration.

Vancouver Computer Systems

Equipment Acquisition. Equipment acquisition and installation required special attention because misunderstandings on the part of the vendor or the project team can delay equipment delivery and increase costs. For example, a problem with the bitpad connection took considerable time to resolve because the vendor had delivered the wrong connection which was not noticed until some time later.

Software Installation. The various software systems were installed as they were developed so that the users would have an opportunity to review and test them before the final product was completed. For example, the multi-user version of DART Manager Plus was installed prior to the installation of the scheduling enhancements. The DART Manager Graphics program was installed long before it was considered to be in finished form. This provided the operator with a system to test and change to fit their needs prior to system acceptance.

Ergonomic Factors. The operators were supplied with proper computer furniture, glare screens, soundproofing screens to separate work areas, and proper ventilation equipment to keep the equipment (and operators) from over-heating in order that the proper environment would be provided.

Staff Training. Training was an important aspect in Vancouver. Individual instruction, which is a one-to-one approach, was used to train users. The user was seated at a terminal and the trainer explained and demonstrated the operation of the equipment and the applications used in the job. The user, after this explanation and demonstration, learned by doing under the guidance of the trainer.

Several follow-up training services were provided to end users. First, if users had any problems with the system, they were told who to call to resolve the problem quickly. Second, each user was periodically contacted, usually in person, to see how the system was working and to see if there were any problems that needed resolving.

Documentation. Good user documentation provides backup and reinforcement to the users' training. It also serves as a historical record of the system. The user documentation for each of the computer scheduling systems consisted of a manual (9,10,11), with detailed instructions on how to install the system and use it for registering clients, reserving trips, scheduling trips and dispatching vehicles. One of the programs also included an on-line tutorial program.

WORKING WITH THE NEW SYSTEMS

The Transitional Period

One of the major considerations in implementing the new brokerage centre in Edmonton was to create a smooth transition from the previous contractor to the new broker manager. The transitional period was required to achieve the necessary changes in both organization structure and the dispatching system technology.

One of the most important factors in creating the smooth transition was the cooperation of the previous contractor in allowing specific staff members to be transferred to the brokerage centre. This was particularly important in the scheduling area where the contractor's staff were the only ones knowledgeable about the operation of the computerized scheduling system. It was naturally felt to be very important to have staff trained on the system when it was taken over.

Labour Relations. Throughout the implementation, specific consideration was given to the potential difficulties which could arise from the challenge of specific unions over the staff of the brokerage centre and/or the drivers for any of the contractors. Care was taken during the transition to deal with all new employees as individuals and not to prejudice nor interfere with their existing union affiliation nor with their future rights to become a new collective bargaining unit.

Nonetheless, on August 3, 1985, after the Brokerage Centre began operations, the Amalgamated Transit Union Local 569 served notice on the Alberta Labour Relations Board that it wished the Board to decide:

1) if the ATU had the rights of succession to the employees as a result of an existing collective agreement with the contractor, and
2) if the DATS system was part of the City of Edmonton Public Transportation System and
3) was therefore included within the collective agreement between the City and the ATU.

The Board undertook its investigations and rendered a decision in January 1986. The significant findings of the Board were:

1) There was no relationship between the previous contractor and the new contractor and no transfer of business took place.
2) "transportation for the disabled would not be public transportation because service is not generally available to the public, rather it is limited to those ... registered as users ..."
3) Each of the contractors was in fact independent of the employer and had normal control of their operations independent of each other.

Public Relations. Another important aspect of the transition in Edmonton was to reassure the user community that the services would not be disrupted as a consequence of the implementation of the new brokerage centre. Two mechanisms were utilized to communicate the changes to the users: (1) the involvement of the DATS Advisory Committee to explain the changes, and (2) the production of a series of newsletters to advise the users of the changes. Telephone decals (which were also produced in Braille by the CNIB) were distributed to all DATS users to advertise the new telephone number of the Brokerage Centre.

In Vancouver, the transitional period only covered the period during which parallel operations were conducted. Since the installation of the computer systems did not affect either the transit drivers or the users of the service, labour relations and public relations were major considerations during the transitional period.

System Transition (Parallel Operations). Even though the programs had been tested, there was no way of knowing whether the system would really operate correctly without duplicating the actual flow of work with all its exceptions and timing considerations. It was felt that the best way to ensure that the new systems would work was to undertake parallel operations. Parallel operations consist of feeding both the old and new systems the same input data and comparing files and output results. Despite the fact that systems testing was undertaken, related conditions and combinations of conditions are likely to occur that were not foreseen. Parallel operations test/confirm the success of the development effort.

System Testing and Acceptance

In Edmonton, on November 17th, 1986, an formal acceptance testing procedure was implemented for the computer system to define those aspects that required changes or improvements by the developer. The acceptance tests covered: hardware, operating system (QNX), database system (ZIM), and included: data validation, reports, screen formats, response times, etc. Although the performance met expectations, some limitations were experienced and system enhancements were undertaken.

In Vancouver, the systems testing and acceptance process was relatively informal since it was a continuing ongoing process during the life of the demonstration project. As the operators became familiar with particular functions of the systems, requests for modifications were made. If the project team felt that the modifications were necessary, the developer and the project team would jointly determine whether requested modifications were a part of the initial contract (i.e. a result of a fault in the original design) or whether a new contract would be required (i.e. an enhancement that was not originally envisaged). Sometimes, a small contract would be awarded to effect the changes.

REVIEWING THE IMPLEMENTATION PROCESS

Significant Events in Vancouver

May 85 Request for Proposals for supply of computer systems issued to short-list of seven suppliers.

Aug 85 Contracts awarded to AIM Software for multi-user version of DART Manager and SRI International for a systems analysis of Pacific Transit.

Sept 85 Purchased hardware for DART Manager Plus.

Oct 85 Installation of multi-user version of DART Manager at Western Society.

Nov 85 File creation and staff training for multi-user DART Manager. Contract awarded to SRI International for DART Manager Graphics. Purchased hardware for Graphics.

Dec 85 Begin operations at Western Society with multi-user version of DART Manager.

Jan 86 Contract awarded to AIM Software for DART Manager enhancements (enhanced version was DART Manager Plus).

Feb 86 Order entry module of DART Manager Graphics installed at Pacific Transit Cooperative.

Mar 86 File creation and staff training for DART Manager Graphics at Pacific Transit.

Apr 86 Debugging of both DART Manager Plus and Graphics systems.

May 86 Installation of DART Manager Plus at the Western Society. Scheduling module of Graphics implemented at Pacific Transit.

Jun 86 DART Manager Graphics moved to new location at North Shore HandyDart. File creation and staff training at new location.

Jul 86 Operations planned for North Shore but are delayed due to bugs in program.

Sept 86 Contract awarded to AIM Software for additional modifications to DART Manager Plus.

Nov 86 Modifications for DART Manager Plus completed and a new version of DART Manager Graphics is delivered and installed.
Full operations for DART Manager Graphics are planned but delayed due to staff holidays.

Dec 86 Installation of modified DART Manager Plus.

Jan 87 Operations begin with DART Manager Plus but are delayed due to system crashes and data corruption problem.
New version of Manager Graphics is installed and operations are planned to begin but are delayed due to contract negotiations.

Mar 87 **Full operations with DART Manager Plus at Western Society and DART Manager Graphics at North Shore.**

May 87 Completion of user manuals for distribution to other operators in Canada.

Significant Events in Edmonton

Apr 85 City Council approves the plan for the implementation of a brokerage management centre in Edmonton.

June 85 Service contracts are tendered and contracts are negotiated with various service providers.

June 85 Newsletter issued to all users advising them of changes to be anticipated in the DATS operation.

July 85 Brokerage centre is established, the site is selected, equipment and furniture is moved to the new facility.

Aug 85 **Start up of the system under brokerage centre management.**
Policy of no-refusals implemented.
Re-evaluation of CT#3 levels of servicing and phasing-in of contract.
Re-evaluation of CT#4 A.C.T. service.
Scheduling responsibilities for A.C.T. put into normal scheduling function.

Sept 85 Yellow Cab Strike. Existing CT#3 contract suspended. Weekly contracting of service to smaller taxi operators.
Additional staff retained in Brokerage Centre to assist scheduling operation. Scheduling responsibilities separated into ambulatory and wheelchair requirement. Internal brokerage procedures altered to remove scheduling responsibility from reservation staff and assigned to scheduling staff. Senior scheduler responsible for the scheduling of master schedules.
Newsletter circulated to all users advising of the final system changes.

Fall 85 Introduction of van services for CT#4 many-to-one service to A.C.T. contract.

Oct 85 Complaints analysis (review of users complaints -- before/after).

Jan 86 Total re-evaluation of existing schedules on CT#1 and CT#2 contracts.

Feb 86 CT#3 contract with Yellow Cab terminated and new contract entered into with Senior Limousine on a flat rate per trip basis.
Van services introduced for subscription trips to schools and institutions.

Apr 86 Existing computers shut down for four-day period to move to new location. In-house micro-based program developed to handle four-day period.

Sept 86 Van contract tendered. Terms of reference for van drivers extended to include the possibility of carrying wheelchair trips where vehicles were suitably-equipped with ramps.
Brokerage Centre renovations commenced to improve layout, provide better communication, and to institute central telephone operator.

Oct 86 New internal system for handling all calls through central operator instituted to improve response time to users.
Operations begin with computer system.

Jan 87 Contracted staff incorporated into civic administration.

What Went Wrong?

Both demonstration projects were completed within the original budget estimate, but all activities occurred considerably later than anticipated. The reasons for the delay were many. In Vancouver, some of the unforeseen circumstances that delayed the project included:

Change in Structure of BC Transit. During the demonstration project, a major organizational change occured at BC Transit that affected all the participants in the project.

Change in Venue for Demonstation. One of the computer systems had to be re-located from one custom transit operator to another operator during the implementation process.

Use of Leading Edge Technology. A number of minor problems were experienced due to the decision to use 'leading edge' technology.

In Edmonton, some of the unforeseen circumstances that tended to delay the project from the original plan included:

Contractual Problems with Taxis. The original contractor for the flat rate sedan contract could not fulfill their contractual obligation. Service was further disrupted by a labour dispute. A second contractor filed for bankruptcy during the demonstration project.

Union Jurisdictional Challenge. Immediately after the brokerage centre began operations, a union jurisdictional challenge affecting the staff and drivers of the brokerage centre was placed before the Alberta Labour Relations Board.

Delay in Computer Implementation. Partly as a result of the preceeding problems, the implementation of the new computer system was delayed.

7. EVALUATION

In both demonstration projects, a decision model was used to analyze, evaluate, and communicate the variables that were a part of the decision-making process. The decision-modeling process consisted of two main activities: defining and evaluating. The 'definition' activity covered several tasks including: selecting the alternatives; defining the criteria; and specifying the performance measures. The alternatives then had to be evaluated according to how well they performed with respect to the evaluation criteria. The 'evaluation' activity included calculating the performance measurements; possibly weighting the criteria; and then determining the overall performance of each alternative and deciding which was the 'best' alternative.

In Vancouver, the project approach was to develop and test several computer software packages for special transit service operators. Consequently, there were several alternatives that required evaluation. The alternatives were evaluated to determine the best alternative for expansion to the other operators in the Vancouver area and for coordination between operators. In addition, the alternatives were evaluated to determine the overall benefits and costs of applying computers to special transit services.

In Edmonton, the project approach was to define and implement a centralized brokerage system. Consequently, there was only one basic alternative to evaluate -- the brokerage management system concept. This evaluation was performed by comparing the new operation to the baseline (i.e. previous operation) alternative. Measuring the effects of the brokerage and the baseline alternative involved measuring conditions before and after the implementation of the brokerage centre.

DEFINING THE EVALUATION PROCESS

Identifying the Alternatives

The first step in building a decision model is to list what choices are available for reaching the goal: the specific alternatives that are to be evaluated during the process.

In Vancouver, the goal was to find the most suitable computer system for expansion to other special transit service operators. The possible choices -- or alternatives -- for reaching the goal were: (1) **Manual Systems,** the baseline alternative signifying the existing situation in which no computer system was used; (2) **Dart Manager Plus,** the enhanced version of the Victoria computer-aided scheduling system using a textual display of information in lieu of scheduling boards; and (3) **Dart Manager Graphics,** the SRI computer-aided scheduling and dispatching system using a graphical information display to aid in the scheduling decision process.

In Edmonton, the goal was to offer the most cost-effective service possible. A quantitative evaluation of the brokerage management system was designed to provide a measure of the impact of the changes made to the system after August 1, 1985, which marked the implementation of the brokerage system. By comparing the 'before case' with the 'after case', a determination of the benefits of the brokerage concept was derived. In addition, actual achievement was compared to projected achievement and various targets for service.

Because a number of events occurred during the projects, three periods in time were used to establish a basis for comparison. These three periods permitted the impact of the brokerage system concept to be evaluated. For the purposes of evaluation, the periods compared included:

- **Before,** the baseline alternative which was the one-year period -- from August 1984 to July 1985 in Edmonton and the fiscal year period 1984/85 in Vancouver -- prior to the implementation of the demonstration projects.
- **During,** the implementation or start-up period from August 1985 to July 1986 in Edmonton and the fiscal year 1985/86 in Vancouver -- the first twelve months of operation when the systems were undergoing many changes/adjustments.
- **After,** the 1986 calendar year in Edmonton and the fiscal year 1986/87 in Vancouver, after the major systems implementation, was a period of a bit more stable operations (but still prior to complete stabilization of operations).

Selecting the Criteria

Every decision is based on conscious or unconscious criteria -- standards by which the alternatives are weighed to come up with the best decision. If the criteria are properly defined, a concrete basis is available for making comparable decisions in the future.

In Vancouver, the criteria that were used were developed from different perspectives: the independent transit operator, the overall transit service, and the funding agency. The categories of criteria from each of the perspectives in turn included: effectiveness, efficiency and economy.

Effectiveness measures included: quality of service, flexibility of operation, implementation requirements, administrative requirements, system response time and system reliability. Efficiency measures included passengers carried per hour, the ratio of productive to unproductive service, reliability of service, and productivity of office staff. Economy measures included acquisition costs, operating costs and benefit/cost ratios.

In Edmonton, the quantitative evaluation criteria were derived in order to measure the overall effects of the system, rather than just the effects on the operators of the service. The quantitative evaluation covered ridership comparisons, productivity comparisons, and cost comparisons.

Since the purpose of the brokerage centre was to provide a range of cost-effective services under the control of a central dispatch office, the overall system evaluation criteria were designed to measure improvements both in productivity and user satisfaction.

The more generalized criteria that were used in this comparative model were developed from the three perspectives of: the users of the system, the transit operator, and the funding agency. The categories of criteria from each of the perspectives in turn included:

- **Effectiveness**, to measure the (non-quantifiable) impacts of the alternatives on the system users in terms of overall factors such as system reliability, user convenience and quality of service, ease of use, user satisfaction, improvements in employee morale, etc.
- **Efficiency**, to measure the quantifiable impact of the alternatives in non-monetary terms on the overall operating efficiency of the transit service in terms of passengers per hour, kilometers per hour, deadhead kilometrage, passengers per vehicle, trip requests per office staff, and other suitable transit service performance measurements.
- **Economy**, to measure the quantifiable impact of the alternatives in terms of an overall cost-benefit effect on the transit service funding agency. Quantifiable costs would include the cost of the system and quantifiable benefits would include the additional passenger trips that could be carried for the same budget.

MEASURING THE PERFORMANCE

Measuring the Effectiveness

In Vancouver, effectiveness was measured by the quality, reliability and convenience of the service resulting from the application of the computer systems in terms of reductions in trip reservation periods, ability to guarantee rides, likelihood of requests being serviced, response time to requests for information, time to book a trip and so forth. The computer systems made it easier and faster to record trip requests with less chance of making mistakes or misplacing the resulting trip request. It also made it easier, faster and more accurate to respond to requests related to the status of a client's trips and other information requests. Therefore, it was concluded that the application of computers improved the quality of service to the users of the service.

In Edmonton, the effectiveness of the brokerage system was evaluated from the perspective of the contractors (the parties responsible for delivering the service), and the customers (the individual users who are served by the system). An essential requirement for the implementation of a successful brokerage operation is the satisfaction of the goals and objectives of the contractors. Although the financial returns were less than expected, they seemed sufficient to maintain the interest of the contractors in providing the service. A survey of all DATS passengers travelling on June 26, 1986 was undertaken to assess the service since the initiation of the brokerage system. In general the response indicated a high level of user satisfaction with the service.

Overall ridership is, in a way, a surrogate measure for the effectiveness of the service. If the quality and reliability of service increases, then the ridership should naturally increase. The changes in ridership during the implementation of the computer systems at each of the operators in Vancouver is illustrated below. The increase in capacity of the DATS system as demonstrated by the ridership increases in the table below was a major benefit to the users and a measure of the overall effectiveness of the operation.

Ridership

Operator	System	Before	During	After
Western Society	DART Plus	88,042	93,806	104,596
North Shore	DART Graphics	36,976	40,414	43,803
Edmonton Brokerage	PSI System	265,727	281,518	298,965

As shown, ridership increased by 18.8% over the period of the demonstration project for the DART Manager Plus installation and 18.5% for the DART Manager Graphics system. Since the overall ridership in the region increased by 21.5% in the same period, from 382,473 to 462,186 annual trips, it is not possible to attribute all the increases to the computer.

Annual ridership increased by 12.5% during the demonstration project in Edmonton. As trips were assigned to more cost-effective services, ridership on the wheelchair-equipped vehicles declined from 190,000 trips to 126,000 trips, indicating that the project was effective in accomplishing its objective of re-allocating trips to lower-cost vans and sedans.

Measuring the Efficiency

In Vancouver, the service efficiency criterion was designed to measure changes in the overall efficiency of the special transit service in terms of passengers carried per revenue service hour of operation. In Edmonton, less emphasis was placed on efficiency considerations and more on cost-effectiveness considerations since the basic premise was to reallocate trips to more cost-effective services.

Overall productivity in terms of passengers carried per hour is a good measure for the effectiveness of the service. It is difficult to measure the productivity of trips assigned to independent vans and sedans in Edmonton since the hours of service weren't recorded. The changes in productivity due to the implementation of the demonstration projects at each of the operators is illustrated below:

Productivity

Operator	System	Before	During	After
Western Society	DART Plus	2.63	2.73	2.87
North Shore	DART Graphics	2.40	2.42	2.45
Edmonton Brokerage	PSI System	2.64	2.41	1.94

As shown, productivity increased by 9.1% for the DART Manager Plus installation and 2.1% for the DART Manager Graphics demonstration. Since the productivity increase for the overall service in the region was 4.1% over the same time period, no more than 5.0% of the increase for the DART Manager Plus can be attributed to the computer. This productivity increase was not realized at the DART Manager Graphics installation since this system was implemented much later in the demonstration project.

The estimates for Edmonton are based on quarterly reports produced during the brokerage demonstration project. Overall productivity, in

terms of passengers carried per hour tended to decrease (by 25.5%) as passengers were re-allocated from the large-capacity, wheelchair-equipped vehicles to smaller vans and sedans. As to be expected, the largest decrease would occur with both the regular service as the ambulatory passengers were assigned to other vehicles and the charter service as small vans replaced the large buses.

Looking at Economy (Costs)

Acquisition Costs

The purpose of this criterion was to provide a measure of the acquisition costs of the system. In Vancouver, at the end of the demonstration project, the major cost for each new installation was the cost of the computer hardware (aside from staff time in learning the system).

The cost of the computer hardware for the DART Manager Plus system was $11,729 plus $859 for each additional terminal that was attached to the system. Thus, for the single-user system that cost was taken as $11,729 and for a typical small multi-user system it was $13,447.

The cost for the DART Manager Graphics is more difficult to present because of the number of possible configurations. For a basic configuration without the graphics terminal, the cost was about the same as the DART Manager Plus, i.e. $11,454. With the addition of a graphics terminal the cost of the single-user system would be $18,354. The cost of each additional workstation was $5,850.

The cost of the computer system for Edmonton was approximately $61,000 -- $27,000 for the software and $34,000 for the hardware. Of the software costs, $10,000 was for license fees, about $6,000 was for customization, $3,500 for disbursements and $7,500 for the source code.

The costs are higher than for Vancouver due to: (1) Edmonton is a centralized system with a larger computer hardware requirement, and (2) Edmonton's software costs are included (since the software in the Vancouver system is public domain software, the cost of the software is not included).

Operating Costs

The purpose of this criterion is to provide a quantitative measure of the operating costs of the brokerage management system versus the previous operation (the computer systems versus the manual system in the case of Vancouver) -- to see if there was any overall reduction in the costs of providing the service that might be attributed to the brokerage concept. The operating cost per passenger (in constant dollars) is shown on the following page.

Cost Per Passenger

Operator	System	Before	During	After
Western Society	DART Plus	$ 8.55	$ 8.61	$ 8.43
North Shore	DART Graphics	$ 9.32	$ 9.38	$ 9.00
Edmonton Brokerage	PSI System	$12.03	$11.12	$10.50

The operating cost per passenger declined by 1.4% for the DART Manager Plus and 3.4% for the DART Manager Graphics. At the same time, for the Vancouver system as a whole, the operating cost per passenger increased by 3.0% in constant dollars. Therefore, the decline in operating cost per passenger could be taken as 4.4% and 6.4% respectively for the Manager Plus and Manager Graphics installation. Based on the service ridership, this operating cost savings translates roughly into an annual benefit of $39,300 for the DART Manager Plus system and $26,000 for the DART Manager Graphics installation.

In Edmonton, the operating cost per passenger (in constant dollars) declined by 14.6% since the beginning of the demonstration project -- from $12.03 to $10.50 per passenger, a savings of $1.53 per passenger trip. Based on the service ridership, this operating cost saving of $1.53 per passenger translates roughly into an annual benefit of $450,000 for the brokerage management centre concept. This would be the annual benefit of the brokerage if it is assumed that all the benefits that were achieved (improved service, more capacity, and so forth) were translated into reduced costs for the service.

To see if these savings are due to an increase in productivity or to lower wage rates, we would have to look at the operating cost per hour. The operating cost per hour for each installation (again in constant dollars) is shown in the table below:

Cost Per Hour

Operator	System	Before	During	After
Western Society	DART Plus	$22.49	$23.51	$24.19
North Shore	DART Graphics	$22.37	$22.70	$22.05
Edmonton Brokerage	PSI System	$31.76	$26.80	$20.37

The operating cost per hour (in constant dollars) increased 7.6% for the DART Manager Plus installation and decreased 1.5% for the DART Manager Graphics installation. Therefore, the benefits for the Plus system are probably under-estimated (if the operating cost were constant, the benefits achieved with the introduction of the computer would have been larger) and for the Graphics system are probably over-estimated.

The operating cost per hour (in constant dollars) decreased 35.9% for the brokerage management centre. Therefore, the benefits accrued to the brokerage centre are largely due to a transfer of benefits from the contractors for the service; i.e. the operators and drivers of the vehicles. Nonetheless, a cost saving for the City has been generated and a benefit for the system as a whole has been achieved.

Payback Period

The purpose of this criterion is to provide an indication of the possible return on the investment in a computer system or a brokerage system. For illustrative purposes, the preceding benefits and costs were used for the evaluation:

Payback Period

Operator	System	Initial Cost	Annual Benefit	Payback Period
Western Society	DART Plus	$ 13,447	$ 39,300	4 mos
North Shore	DART Graphics	$ 18,354	$ 26,000	8 mos
Edmonton Brokerage	PSI System	$500,000	$450,000	13 mos

As shown, from the results of the project in Vancouver, an investment in a computer-aided scheduling system for a small custom transit operator (assuming there are no large system development or software customization costs) should result in savings that would more than pay for the acquisition costs of the computer within one year. The savings are largely due to the improvements in office efficiency that results from the application of computers -- improvements that are translated into service improvements. It was noted that the computer will not actually ensure that a more productive schedule will result.

To obtain an estimate of the payback period in Edmonton, the overall system implementation costs and resulting benefits were estimated since the benefits of the computer by itself could not be estimated. It is noted that an investment in a brokerage management system (assuming that lower wage rates can be achieved with the service contractors) should result in savings that would more than pay for the investment in the system within a little more than a year.

As well, the brokerage concept achieved non-operating cost benefits which are not reflected in the preceding analysis, such as a reduction in capital funding requirements. In summary, the brokerage management system reduced costs per trip, maintained actual net costs over the two-year period, accommodated an increase in ridership, improved fleet management and vehicle investment requirements, and more effectively matched requirements with service options with marginal losses in productivity.

THE RESULTS OF THE EVALUATION

In Vancouver, the results of the decision model indicated that many benefits can accrue from the acquisition of a computer-aided scheduling system. These benefits which accrue directly to the transit operator can usually be translated into an improvement in the overall productivity of the service that is provided. The evaluation which attempted to define which of the two computer systems was better than the other was not as definitive. A sensitivity analysis was conducted that indicated that both computer systems are very similar and neither can be said to be better than the other.

In Edmonton, the results of the decision model indicated that many benefits can accrue from the implementation of a brokerage management system. These benefits which accrue directly to the funding agency can usually be translated into an improvement in the overall quality of the service that is provided to the users.

Concluding Remarks from the Evaluation

It is concluded that computerization has considerable benefits compared to manual systems. It is concluded that the two different computer systems that were tested in Vancouver have advantages and disadvantages that make choosing between them difficult. Therefore, it is recommended that operators interested in using either one of the systems conduct the investigation themselves by actually trying each system out and then deciding which fits the way that they actually do things.

It is concluded that the brokerage management concept accomplished its objectives of providing a range of cost-effective services and of reducing costs by matching individual passengers with the most cost-effective service option. It is also indicated, however, that the current economic climate in the City of Edmonton contributed significantly to the lower costs since the contractors bidding on the service tended to bid significantly lower than they have for previous contacts.

8. CONCLUSIONS

Both the Edmonton and Vancouver scheduling/brokerage demonstration projects illustrated the feasibility of using computer systems to improve coordination of services for disabled persons. The projects provided an indication of the potential benefits to be achieved by coordinating a mix of public and private service providers in transit services for elderly and disabled persons. They illustrated the benefits of using computers to assist in this coordination aspect. They also illustrated the ease with which operators of these special transit services can adapt to new technology and use it to improve client services.

The objective of both demonstration projects was to improve the quality and cost-effectiveness of urban transit services for disabled persons through the selection, implementation and demonstration of computerized scheduling/brokerage systems, with particular emphasis on the best application of microcomputer technology to the personalized form of transportation offered by special services.

Vancouver and Edmonton used different approaches to meet the objective. In Vancouver, emphasis was placed on the application of technology to assist existing operators -- the development of technology to meet the current needs of the users. In Edmonton, the emphasis was placed on the development of an administrative structure to contract with various operators -- the technology was then used to support the new structure.

In Vancouver, the purpose of the brokerage demonstration project was to develop and provide microcomputer systems to the small locally-based operators of custom transit services in the region and then to provide a means for them to communicate easily with each other so that they could

better coordinate their services (especially regional services) that they were providing to the clientele in their service area. Public domain, easily-transferable, software packages were developed and consequently, the state-of-the-art of technology was further advanced.

In Edmonton, the purpose of the brokerage demonstration project was to determine (1) what results could be achieved through matching of vehicle with user requirements and (2) how this could be accomplished within an organizational framework of public and private ownership, operation and responsibility. Consequently, the state-of-the-art of organizational and contractual arrangements was further advanced. Use of computers to support these arrangements, however, went from a sophisticated (but troublesome) computerized scheduling system to a relatively simple proprietary bookkeeping and data base management system.

IMPLICATIONS OF THE PROJECTS

What Computers Mean to Transit Operators

In Vancouver, two computer-aided scheduling systems for operators of special transit services were tested and demonstrated that should have wide applicability throughout the industry in Canada.

One of the applications sponsored utilizes low-cost graphical display technology to improve the scheduling/dispatching function in shared-ride transportation environments. Operating on a local area network, the system provides a graphical display of available services and current demands as a scheduling/dispatching aid for operators.

The other application sponsored was a computer software package for microcomputers that provides assistance in the client registration, trip reservation and management information function of special services. This application also provides scheduling assistance through a tabular display of schedules for the operator. It will also operate on a multi-user microcomputer configuration.

The computer software packages should allow other operators in Canada to better handle information. Internal office improvements should then be translated into overall system productivity improvements that will allow more service to be provided to the users of the service at less cost. For office staff -- the call-takers, dispatchers and schedulers -- paperwork is greatly reduced with computers. Mistakes from hand-written notes are reduced. It is easier to train new staff with a computer system in place. Drivers don't have to copy out their daily run sheets.

Lead time requirements for advance bookings are reduced since schedules are developed in a shorter time. Some operators, in fact, refuse to accept trip requests after a certain time during the day so that schedules can be prepared. With the computer system, this cut-off time can be delayed until later in the day.

Once a computer system is in place, some operators have also found that they can easily add more service with no additional office staff requirements. One of the operators in Vancouver, for example, added two additional vans with no additional office staff.

What Brokerage Means to Contractors

The brokerage concept clearly has permitted the private sector and especially the smaller business to participate in the provision of service. Service to the handicapped population is very difficult for the private sector operators to capture without some coordinating mechanisms. The investments in vehicles, equipment, and time is substantial and requires a significant volume of business to generate an adequate economic return. Since individual taxi companies can capture only parts of the market, it is very difficult for a taxi company to support dedicated vehicles and drivers to this service. One Edmonton taxi operator, however, with a significant clientele able to pay private rates, did specialize in serving the wheelchair community on a private basis for a short period.

Establishment of the Brokerage Centre and the contracting of trips to a number of smaller operators has permitted those operators to justify the investment in wheelchair lift equipment. As a result, there is now in the City a significant pool of private wheelchair-equipped vehicles for hire. These operators are now in a position to be able to expand their areas of service to the private wheelchair market which has been without service for some time.

The taxi service for ambulatory patrons has proved troublesome for the taxi companies and the individual taxi drivers. Because of the wide fluctuations in daily demand it is clear that a large fleet of vehicles is required and a fleet which is flexible and not directly tied to a series of contracts with fixed parameters. Secondly, it is clear that the operators, especially of owner-operated vehicles, are not willing to provide the service at a marginal cost. Thirdly, the individual taxi owner-operator is not the contracting party since the DATS operation contracts with the taxi firm which is itself a broker. Therefore, individual operators do not have direct allegiance to the contract.

Owner-operator drivers do not view the DATS service as a main part of their business and therefore are not willing to sacrifice income to maintain these trips. From the operators point of view, return from a DATS trip must be competitive with what they would receive from a

metered trip. The latest sedan contractor surveyed the meter cost of each trip and determined that the current rate was very close to the meter rate. Given that the demand for service can fluctuate widely from day to day, as well as from season to season and given that this contract has no minimum guarantee, it may be reasonable to assume that an individual owner-driver would feel little commitment to their DATS contract.

What About Custom Transit Clients

In Edmonton, the introduction of the brokerage concept has increased the reliability and comfort for many individual users because of the range of equipment available for service. The improved scheduling permitted by the centralization in the Brokerage Centre has increased the expectation level of the user community. By instituting a no-refusals policy, which was a consequence of having the taxi contract, and by introducing innovations such as the van service, user demands and expectations of the system have increased. The brokerage concept in fact has permitted the DATS service to retain a high level of service and a high level of responsiveness when in fact budgetary resources have been reduced.

The introduction of a computer system can reduce the average telephone dwell time for the trip reservation process -- improving the quality of service for the user as well as increasing the productivity of the office staff. Clients' requests for trip status and other information are also handled more quickly and easily.

Service quality is also improved as measured by: (1) the difference in times confirmed to clients and actual pickup and dropoff times, (2) the number of scheduling errors or omissions, and (3) the percentage of unmet trip requests. In short, a computer system can help the office staff provide a better, more responsive service to their clientele.

Implications for Administrative Agencies

The implementation of the brokerage concept with direct responsibility for the scheduling, dispatch, and administrative functions has significantly improved the control of cost, service levels, and the development of management policies, etc. for the municipality.

On the other hand, the DATS brokerage concept has introduced additional complexity into the procurement and financial administrative sides of the City. The flexibility and the day-to-day adjustments needed to meet service demands through a number of contractors often creates problems for the more rigid and formalized tender and contract administration functions followed by the procurement and financial officials of the City. Within the municipal structure, the need to demonstrate accountability often frustrates operational managers responding to daily demands.

The implementation of a computer system should improve the accuracy and timeliness of management information reports. Reports are naturally easier to produce with the assistance of a computer to retrieve and tabulate the raw data. The raw data, once entered into the computer, can be tabulated and presented in a variety of forms to make it easier to monitor and manage the service in a cost-effective manner. Better reporting ensures better accountability for the funds expended on the special service.

On the other hand, the support requirements for operators that decide to computerize should not be underestimated. Pre-implementation support, in terms of training (even general computer introduction), is extremely important. Ongoing support -- responding to questions, maintaining hardware and software, customizing programs to meet specific needs -- is a continuous and time-consuming, but absolutely necessary, activity.

Implications for Other Jurisdictions

The implementation of a brokerage concept is dependent upon the availability of contractors with a range of vehicle capabilities prepared to provide service on a competitive basis. Edmonton's ability to implement a brokerage demonstration project was facilitated by the existence of a relatively open market in the transportation industry. As a result, both the taxi and bus industries are very competitive and the cost of entry is relatively low for new entrepreneurs. As a result, the City of Edmonton was able to tender for services and receive very competitive bids both in terms of cost and level of service.

The computer-aided scheduling systems in Vancouver were developed using public funds to ensure that the resulting software packages would be available in the public domain at the end of the demonstration project. They were also developed for a hardware configuration that, at the time, appeared to be the most common for business applications -- the IBM PC and compatible class of computers.

The demonstration project in Vancouver, therefore, ensured that a series of software packages for assisting operators of special services would be readily available to other jurisdictions in Canada at a nominal cost. This attempt at developing generic software will help other small special operators in Canada to realize the benefits that large operators have realized in developing their own site-specific systems.

The transferability of experience through the distribution of the software packages is the most important implication for other jurisdictions resulting from the Vancouver demonstration project. If other operators start to use the software and if they can get together and form a user group, the software for small operators will continue to be available and will probably continue to be upgraded and improved.

A second factor of importance from the Edmonton experience was the problems introduced by existing labour relations. Since Edmonton was not directly providing service through city-employed staff, the issue of contracting out and privatization of the service was not a direct issue. Indirectly, however, labour relations considerations were important to all parties. Although the Alberta Labour Relations Board substantiated the integrity of the contracting structure which was put in place, other jurisdictions with different labour legislation may face a different cost benefit structure.

CONCLUSIONS

In Vancouver the following conclusions were derived from the results of the computer-aided scheduling/brokerage demonstration project:

1) The application of computers to small operators of special transit services does improve office efficiency which is translated into service productivity improvements. Work still remains to be done, however, to provide more scheduling assistance.

2) Two systems were successful implemented. Each system meets the requirements in a different way. Since each operator has a unique method of scheduling and dispatching, it is really up to potential users to decide which system is best for them. In the Vancouver region, more operators have chosen the DART Manager Graphics package.

3) The development of public domain software packages for IBM-standard computers provided for readily-transferable software and advanced the state-of-the-art of computerized scheduling systems in Canada.

4) User involvement in the selection (or development and testing) of computer systems is absolutely essential and the interest and involvement of the users in Vancouver was a key reason for the success of the systems.

5) The development and testing of computer systems takes considerably longer than anticipated. The process also requires considerably more support on behalf of technical and project management staff than anticipated.

6) Although the feasibility of providing an area-wide, local area network using the telephone system to connect computers was confirmed, the practical and operational aspects of the concept have not been tested.

7) From a provincial funding agency point-of-view, the capability of a number of operators to use a common computer program that can be used to produce standard machine-readable monthly summary reports was an additional benefit.

CONCLUSIONS

In Edmonton, the following conclusions were derived from the results of the scheduling/brokerage demonstration project:

1) The brokerage concept did produce improvement in cost effectiveness in mean cost per hour and mean cost per trip.

2) The brokerage concept permitted the DATS service to accommodate additional levels of demand within a reduced budget allocation.

3) The brokerage concept introduced innovations in the way services were provided; for example, by contracting out service to individual van operators utilizing 10-passenger vehicles.

4) The brokerage concept provided much better control and management information to both City management and the DATS operator. The centralization of complaints and user feedback for example, provided a much more effective measure of consumer response.

5) The brokerage concept provided the opportunity for more effective scheduling and use of the City's fixed cost in its vehicle fleet. It also provided the City with a better information base to plan future capital purchases of vehicles and equipment.

6) The use of a computerized data base management system provided the necessary support for the brokerage concept; but, since a relatively-sophisticated computerized scheduling system (with an automatic scheduling feature) was abandoned in the process, the state-of-the-art of technology essentially took a step backwards.

7) The use of a proprietary computer software package makes it difficult to transfer experience (such as improvements in the software) to other operators in Canada. Other operators wishing to obtain the package will have to continue paying the system developer's publicly-funded research and development costs.

8) The unique labour and economic climate in Edmonton at the time of the demonstration project introduced conditions which would probably not be replicated in other areas in Canada. Thus, the transferability of brokerage operation experience to other areas may not result in the same level of benefits.

RECOMMENDATIONS

Finally, the following recommendations have resulted from the demonstration project in Vancouver:

1) BC Transit (and possibly other Provincial transportation agencies) should establish an information support centre to provide ongoing advice and support for special transit service operators in their jurisdictions that decide to obtain computer-aided scheduling systems.

2) As a next step, BC Transit should establish a regional communications network in the Vancouver area so that operators with computer systems can more easily exchange information related to trip requests that pass beyond local operators service areas.

3) If the software packages find wide application throughout Canada, Transport Canada should investigate potential improvements to the software, such as heuristics for automatic trip assignment suggestions.

4) If the software packages find wide application throughout Canada, the operators should form a user group that could act as an advice and support centre for themselves.

And the following recommendations have resulted from the demonstration project in Edmonton:

1) Existing municipal transit commissions or departmental administrative organizations should consider the brokerage management system as a means of coordinating services provided for disabled persons by public and private operators.

2) The City of Edmonton should closely monitor the cost-effectiveness of individual trip assignments on both an average cost and a marginal cost basis in the event that overall economic conditions improve and operating costs increase for the private vehicle service providers.

3) Transport Canada should continue its research and development efforts related to computerized scheduling/dispatching systems since this is the single most important element controlling the reliability, productivity and cost-effectiveness of special transit services.

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